THE

Religious Philoſopher:

Or, the Right Uſe of

Contemplating the Works of the CREATOR.

I. In the wonderful Structure of Animal Bodies, and in particular MAN.

II. In the no leſs wonderful and wiſe Formation of the ELEMENTS, and their various Effects upon Animal and Vegetable Bodies. And,

III. In the moſt amazing Structure of the HEAVENS, with all its Furniture.

DESIGNED

For the Conviction of ATHEISTS *and* INFIDELS.

Throughout which, all the late Diſcoveries in *Anatomy*, *Philoſophy*, and *Aſtronomy*, together with the various Experiments made uſe of to illuſtrate the ſame, are moſt copiouſly handled by that Learned Mathematician, Dr. *NIEUWENTYT*.

Tranſlated from the Original,

By JOHN CHAMBERLAYNE, *Eſq*; *F. R. S.*

To which is Prefix'd,

A LETTER to the TRANSLATOR, by the Reverend *J. T. Deſaguliers*, *M. A.* F.R.S.

Adorn'd with CUTS.

LONDON:

Printed for J. SENEX in *Salisbury-Court*, and W. TAYLOR, at the *Ship* in *Pater-Noſter-Row*. M DCC XVIII.

THE

Religious Philosopher:

Or, the Right Use of

Contemplating the Works of the

CREATOR.

I. In the wonderful Structure of Animal Bodies, and in particular MAN.

II. In the no less wonderful and wise Formation of the ELEMENTS, and their various Effects upon Animal and Vegetable Bodies. And,

III. In the [illegible] Structure of the HEAVENS [illegible]

For the Conviction of [illegible] INFIDELS.

MVSEVM BRITAN NICVM

Throughout which, all the late Discoveries in Astronomy, Philosophy, and Physick, together with the various Experiments made use of to illustrate the same, are most copiously handled by that Learned Mathematician, Dr. NIEUWENTYT.

Translated from the Original,

By JOHN CHAMBERLAYNE, Esq; F.R.S.

To which is Prefix'd,

A LETTER to the TRANSLATOR, by the Reverend J. T. Desaguliers, M.A. F.R.S.

Adorn'd with CUTS.

LONDON:

Printed for J. Senex in Salisbury-Court, and W. Taylor, at the Ship in Pater-Noster-Row. MDCCXVII.



TO THE

Moſt HONOURABLE

The Lord *PARKER*,

Lord High-Chancellor of *Great-Britain*, &c.

My LORD,

YOU gave an Intruder ſo kind a Reception at his firſt Addreſs, that he is delighted with a Pretence to make you a ſecond. My firſt Attempt was to preſent Your Lordſhip with imperfect Copies, after my manner, of the Originals of ſeveral Famous *French Philoſophers*, drawn by one of the beſt Hands, that of the moſt Ingenious *Fontenelle*; than whom

Sir

Sir *Godfrey Kneller*, our *Britiſh Appelles*, can hardly give an Object a more agreeable Likeneſs.

Now, my Lord, I am going to entertain You with a Picture of another kind, drawn by an Honeſt Plain *Dutch Philoſopher*; *viz.* a *Sketch of Divine Wiſdom and Providence* diſplay'd in the *Works of the Creation*; whoſe maſterly Strokes affect the Mind with a due Admiration for the Original, which he has ſo well Copied.

This Treatiſe of Philoſophy, the Author calls *The Right Uſe of the Contemplation of the World*, &c. Thro' the whole of which, there runs ſuch a Strain of unaffected Piety, that I doubt not but his good Intentions, (even tho' he had not executed them ſo well as he has done) muſt have already procured him the inward Satisfaction of that Glorious Promiſe made to the Father of the Faithful, and thro' him to all Believers; *I will be thy Shield and exceeding great Reward.*

My

My Lord, I beg leave to call the Learned Phyſician, who is my Author, the Dutch *Ray* or *Derham*, becauſe, like thoſe two *Engliſh* Philoſophers, he has ſo well prov'd the *Wiſdom*, Power, and *Goodneſs* of GOD by the ſtrongeſt Arguments, *Obſervations* on *Facts*, and *Demonſtrations* drawn from *Experiments*. It were to be wiſh'd, that he had apply'd the Texts of Scripture, which he quotes, as properly as he has done his Philoſophical Conſiderations; but ſince he has not ſo well ſucceeded in what may be call'd *his Divinity*, I have left ſeveral of the Texts out of this Tranſlation; but have retrench'd none of his Gloſſes upon the particular Texts by him quoted, nor any of his Glorious Tautologies, in which he does ſo often call upon *Atheiſts* and *Infidels*; excepting where his Comment is wrong, or the Repetitions are too tedious and, I hope, unneceſſary, even for convincing of thoſe unhappy Men to whom he addreſſes himſelf; of whom it may be pronounc'd, that if they ſtill perſiſt in the Denial of a GOD, after ſo many irrefragable Arguments, drawn from the wonderful Structure of Humane Bodies, and all the

the other Glorious Works in the Universe, GOD will then *harden their Hearts*, and, like the Pharisees, they will not *be perswaded, tho' one rose from the Dead.*

However, my Lord, that I may not be thought to have acted rashly in leaving out any thing of my Author's, I have in this followed the Advice of several of my learned Friends *both Philosophers and Divines* (to whom I communicated some of these *Sheets* in MS.) and if I only said that your Lordship approv'd of this design'd Omission, the World wou'd be assur'd that I had consulted a Philosopher and a Divine; for as the *Royal Society* well know how Eminent your Lordship is in the first of these Qualifications; so many of the *Clergy* know, that a very able Prelate (now with God) and one mighty in Scripture-Learning, has openly profess'd, that *the Lord* PARKER *is one of the greatest Divines in* England.

And here, my Lord, it may not be amiss to suggest to You, how great a Trouble I have met with, in teaching my Author to speak *English*; who by his affecting to express all his Technical Words or Terms of Art in his pure vernacular Tongue, such as, for instance,

inſtance, the *Veins*, *Arteries*, *Muſcles*, *Fibres*, *Nerves*, and a thouſand other *Anatomical*, *Phyſical*, and even *Mathematical* Words too, has made me take Pains unknown to my indolent Temper thro' the whole Courſe of my Life till now; for I have not been able to procure any help in this Caſe, neither from the Living nor the Dead: Indeed the Tables and Figures of my Author (which are very curious, and taken from the moſt valuable Anatomiſts and Philoſophers) have been of good uſe to me, where there are proper References; but thoſe were the only Aſſiſtances I could procure here in *England*; ſo that for the reſt, I ſhould have been forced to gueſs at their Meaning, if my Learned Friend Mr. *Sgraveſande* (*Profeſſor* of *Mathematics* and *Experimental Philoſophy* at *Leyden*) had not kindly interpreted to me thoſe I could not unriddle; for there is no more Analogy between my Author's Terms and the *Latin* or *Greek* commonly us'd by all other Philoſophers, than there is between them and *Hebrew* or *Arabic*. My Lord, I don't

ſay

ſay this to Praiſe my ſelf or Blame my Author (who is rather to be commended for keeping up the Dignity of our Siſter-Tongue, Daughter of the *Teutonic*, and Grand-daughter of the *Gothic*, the common Spring of all the Weſtern Languages of *Europe* from North almoſt to South; and indeed we ourſelves are not to be juſtify'd in Loſing and Obſoleting ſo many of our moſt ſignificant *Anglo-Saxon* Words and Phraſes, as has been well obſerv'd before me by the Learned Mr. Baron *Forteſcue* †) but to leſſen my own Fault, and more eaſily to obtain your Lordſhip's Pardon, if the Difficulty of explaining thoſe Terms has made me commit any Blunders.

I can't conclude, my Lord, without endeavouring to prevent your Lordſhip in favour of my Author, on account of one good Quality, which for being ſo rare and uncommon to moſt Writers,

† In his Ingenious Remarks upon the Lord Chancellor *Forteſcue*'s Book, intituled, *The Difference between an Abſolute and Limited Monarchy. Lond.* printed for *E. Parker*, 1714.

Writers, makes it appear the more lovely and charming in my Eyes; it is that altho' he paſſionately endeavours throughout his whole Work, (and repeats it ſo often, almoſt in every Section) to magnify the Wiſdom and Goodneſs of GOD, and to point out his Great Ends and Purpoſes in all the Works of the Creation: Yet he is ſuch an Enemy to Pious Frauds, and to the ſupporting any of the Divine Attributes above-mention'd, by wrong, or even doubtful and precarious Arguments, that he uſes none in confuting the *Atheiſt* and *Sceptic*, but ſuch as will bear even Mathematical Demonſtration: This has made him a little too ſtrict, it may be, in placing under the Claſs of *Things unknown*, the *Motion* of the *Earth*, and the reſt of the *Planets* about the *Sun*, as that great Philoſopher Dr. *Clarke* was pleas'd to obſerve, when I communicated to him the Contents of this Work: *That he could not but wonder extreamly, that in the* 29*th Contemplation, the Motion of the Earth ſhould be placed among Uncertainties, after that the Parallax of the Annual*

Annual Motion is ſo notoriouſly Apparent in the Phænomena of Comets, &c.

But I forget, my Lord, that I am waſting thoſe precious Minutes which your Lordſhip employs ſo uſefully in the Service of your King and Country: That you may long employ them ſo, is the ſincere and hearty Wiſh of,

My LORD,

Weſtm. May 13. 1718.

Your Lordſhip's

Moſt Obliged, Faithful

and Moſt Humble Servant,

J. CHAMBERLAYNE.

Advertiſement.

I Muſt here beg my Readers Pardon, for making my Title Page different from the Running-Title; and now calling my Author the *Religious Philoſopher*, inſtead of the *Chriſtian Philoſopher*, which Name was only ſuitable to my firſt Plan, of publiſhing all his Arguments drawn from *Reveal'd Religion*.

A LETTER FROM *The Reverend Mr.* Deſaguliers *to* John Chamberlayne, *Eſq*; *relating to the following Treatiſe.*

SIR,

I Have read your Tranſlation of Dr. *Nieuwentyt*'s excellent Treatiſe; and highly approve your Deſign of Publiſhing it, as it will be of great Service to *Religion* and *Philoſophy*.

THE Doctor's Reaſon *that he gives* for writing his Book in *Dutch* (namely, that a great many Atheiſtical Books, having been written in that Language, he choſe to confute the Oppoſers of a Providence in the ſame) *will be* as powerful a Motive for the *tranſlating it into Engliſh*; ſince we have not been behind-hand with our Neighbours in publiſhing the impious Conceptions and blaſphemous Raillery of our Scoffers at Religion. If ſuch of them as had been

been able, had *publiſh'd* their crude Notions in any of the learned Languages; their Books wou'd have needed no Anſwer; their Readers wou'd have deſpis'd them: But their Proſelytes are gain'd among the Weak and Ignorant, or ſuch conceited Debauchees as are glad to be ſupply'd with Means of defending their Immoralities, by attacking Religion with a ſhew of Wit and Argument.

WHEN an *Atheiſt* has the Impudence to call himſelf a PHILOSOPHER, ſome Well-meaning Perſons that have not much look'd into Nature, are apt to be prejudic'd againſt the Study of it; as if the *Philoſophy and vain Deceipt*, againſt which the Apoſtle has warn'd us, had been the Contemplation of *the Works of the Creation*: Whereas it was only the Sophiſtry of the Schools, contriv'd to diſguiſe Error, and defend the Syſtem of the Superſtitious Heathen Divinity.

HE that reads *Nieuwentyt* will eaſily ſee that a *Philoſopher* cannot be an *Atheiſt*; and if it were true, that a Smattering in *Phyſicks* will give a proud Man a Tincture of *Atheiſm*, a deep Search into Nature will certainly bring him back to a Religious Senſe of God's Wiſdom and Providence.

THO' we have lately had ſeveral very good Books upon this Subject, this will not be leſs acceptable, becauſe it contains ſeveral fine Obſervations

ſervations and Experiments, which are altogether new, as is alſo his manner of treating the moſt common *Phænomena*; from which he deduces admirable Conſequences in favour of a Religious Life. And I think I may ſay this for the *Tranſlation*, that it will perhaps do more Good than the Original; becauſe in giving us all his Arguments for Natural Religion, you have omitted thoſe which his too eager Zeal made him alſo draw from the *Modern Philoſophy for Reveal'd Religion*; the Weakneſs of which latter might give thoſe *Free-Thinkers* occaſion to triumph, who would be ſtruck dumb at Convictions from the former. If I can be of any Service in helping you to look over the Sheets, you may readily command, Sir,

Your moſt Humble

Channel-Row Weſtminſter, Feb. 2. 171⅞

And Obedient Servant,

J. T. D.

P. S. I have juſt now receiv'd the late Monſieur † *Bernard*'s Summary Account of *Nieuwentyt*, *&c.* and do believe that the Readers will be very well pleas'd to find it at the Head of your Tranſlation; becauſe this Gentleman has taken more than ordinary Pains to do our Author juſtice in his *Journal des Sçavans*.

---

† Profeſſor of Philoſophy at *Leyden*, and a famous Member of the Common-wealth of Learning.

THE CONTENTS OF Dr. *Nieuwentyt's Contemplations.*

CONTENTS *of the* Preface, *or* Introduction.

Sect. I. THE *true Difference between Atheiſts, and thoſe that fear* GOD.

Sect. II. *In order to bring Atheiſts to Reaſon, it is neceſſary to enquire into the Cauſes and Remedies of Atheiſm.*

Sect. III. *The firſt Cauſe, is Inordinate Self-Love.*

Sect. IV. *The Means to prevent Inordinate Self-Love.*

Sect. V. *The ſecond Cauſe, is Inordinate Ambition.*

Sect. VI. *The Remedy thereof*

Sect. VII. *Of the Death of* Spinoſa.

Sect. VIII. *The third Cauſe, is Ignorance.*

Sect. IX. *How to prevent that Evil.*

Sect. X. *The fourth Cauſe, too great a Conceit of our own Wiſdom.*
Sect. XI. Spinoſa *briefly confuted.*
Sect. XII. *The Remedies againſt the fourth Cauſe.*
Sect. XIII. *The Firſt Step to Atheiſm.*
Sect. XIV. *The Means to cure Men of Prejudices.*
Sect. XV. *The Second Step, the wrong manner of deſcribing Nature.*
Sect. XVI. *The Inconvenience of deducing every thing from an Hypotheſis.*
Sect. XVII. and XVIII. *The Remedies thereof.*
Sect. XIX. *The Uſe of Hypotheſes.*
Sect. XX. *A Third Step to Atheiſm, is admitting no Final Cauſes.*
Sect. XXI. *The Remedy thereof.*
Sect. XXII. *A Fourth Step, Diſputes.*
Sect. XXIII. *The Remedy thereof.*
Sect. XXIV. *The Abuſe of Academical Diſputes.*
Sect. XXV. *The Fifth Step, Inattention.*
Sect. XXVI. *The Remedy.*
Sect. XXVII. *Why the Author uſes no other Proofs but ſuch as are drawn from Natural Philoſophy.*
Sect. XXVIII. *Becauſe God is pleas'd to uſe the ſame in his Holy Word.*
Sect. XXIX. *The General Proof, or Demonſtration of a GOD.*
Sect. XXX. *A particular Manner of corroborating theſe Proofs,* &c.
Sect. XXXI. *A General Proof that the Scriptures are of a Divine Original.*
Sect. XXXII. *No Proof can be brought of the Divinity of the Alcoran,* &c.
Sect. XXXIII. *A ſhort Account of what is propos'd to be done in the following Work.*

CONTEM-

Contents of the CONTEMPLATIONS.

CONTEMPLATION I. *Page* 1

Of the Vanity of all Worldly Things.

Sect. I. *Every Man is placed here without his own Concurrence;*
Sect. II. *And muſt be convinced of the Uncertainty of his Life.*
Sect. III. *He muſt alſo be convinced of the Vanity of all Worldly Things with reſpect to himſelf.*
Sect. IV. *It is not deſirable to Live here always, tho' in Health.*
Sect. V. *The Miſerable Condition of the Atheiſts.*
Sect. VI. *The Advantages of thoſe that Love and Fear GOD.*
Sect. VII. *It is therefore neceſſary to ſeek for the Demonſtrations of a GOD.*
Sect. VIII. *The Tranſition to the following Contemplations.*

CONTEMPLATION II. *pag.* 11

Of all that is Viſible, and of our Selves in particular.

Sect. I. *It is neceſſary to call upon GOD at the beginning.*
Sect. II. *GOD's Eternal Exiſtence prov'd from the Creatures.*

Sect. III. *The same prov'd from* Romans 1. 20.
Sect. IV. *The Contemplation of our selves in general.*
Sect. V. *The Contemplation of our Bodies, which is Earth.*
Sect. VI. *The Body does not think.*
Sect. VII. *The Soul Demonstrated.*
Sect. VIII. *No Man proceeds from himself, nor from his Parents, but from Another.*
Sect. IX. *Our Support is from another.*
Sect. X. *And this other Being either Knows, or is Ignorant of what he does.*
Sect. XI. *Our Maker and Preserver is Wise, Mighty and Merciful.*
Sect. XII. *Transition to the following Contemplations.*

CONTEMPLATION III. *pag.* 26

Of some Particulars in the Mouth.

Sect. I. *Concerning the Teeth.*
Sect. II. *Of the Enamel of the Teeth.*
Sect. III. *Of the Lips.*
Sect. IV. *Of the Glands of the Mouth.*
Sect. V. *Of the Tongue.*
Sect. VI. *Of the Throat.*
Sect. VII. *Of the Wind-pipe.*
Sect. VIII. *Convictions from what has been said before.*
Sect. IX. *About Sucking, and of Places from which the Air is exhausted.*
Sect. X. *Of Sucking, as perform'd by Children.*
Sect. XII. *Convictions from the foregoing Observations.*

CON-

CONTEMPLATION IV. *pag.* 38

Of the Throat, Stomach and Bowels.

Sect. I. *Concerning the Throat.*
Sect. II. *Of the Streight and Circular Fibres of the Throat.*
Sect. IV. *Convictions from thence.*
Sect. V. *Of the Stomach.*
Sect. VI. *The Fluids of the Stomach, and Muſcular-Valve.*
Sect. VII. *The Fibres of the Stomach.*
Sect. VIII. *The Mucilage of the Stomach.*
Sect. IX. *Of Hunger.*
Sect. X. *The Uſes of the Guts.*
Sect. XI. *The Meſentery.*
Sect. XII. *The Glands of the Inteſtines.*
Sect. XIII. *The Wrinkles, Valves, and* Inteſtinum Rectum.
Sect. XIV. *The Uſes of the oblique and lateral Muſcles of the Belly.*
Sect. XV. *The Uſes of the Pyramidal Muſcles.*
Sect. XVI. *The Uſes of the Streight Muſcles.*
Sect. XVII. *The Orifices in the Muſcles for Seminal Veſſels.*
Sect. XVIII. *The Voluntary and Spontaneous Motions of the* Inteſtinum Rectum.

CONTEMPLATION V. *pag.* 55

Of the Venæ Lacteæ, *and* Ductus Chylicus.

Sect. I. *The Tranſition.*
Sect. II. *The* Venæ Lacteæ, *and* Receptaculum Chyli *in a Dog.*
Sect. III. *The Receptacle of the Chyle in Human Creatures.*

Sect.

Sect. IV. *The Course of the Chyle to the Heart.*
Sect. V. *The Valves in the* Ductus Chyliferus, Venæ Lacteæ *and* Vasa Lymphatica.
Sect. VI. *The Protrusion of the Chyle.*
Sect. VII. *The Valve in the* Vena Subclavia.
Sect. VIII. *Convictions from the foregoing Observations.*

CONTEMPLATION VI. *pag.* 65

Of the Heart.

Sect. I. *The general Use of the Heart.*
Sect. II. *The Description of the Heart.*
Sect. III. *The Eminence or Protuberance in the* Vena Cava.
Sect. IV. *The Auricles of the Heart.*
Sect. V. *The Operation of the Heart.*
Sect. VI. *The Course of the Muscular Fibres.*
Sect. VII. *The Action of the Valves in the Veins.*
Sect. VIII. *Convictions from the foregoing Observations.*
Sect. IX. *The Valves of the Arteries.*
Sect. X. *The Lateral Muscles of the Heart.*
Sect. XI. *The Force and Power of the Heart represented by Comparisons.*
Sect. XII. *The* Pericardium, *or Little Bag of the Heart.*
Sect. XIII. *Convictions from the foregoing Observations.*

CON-

CONTEMPLATION VII. pag. 79

Of Respiration.

Sect. I. *The Air is necessary to the Blood.*
Sect. II. *The Blood-Vessels and* Aspera Arteria *in the Lungs.*
Sect. III. *The Glands in the Wind-pipe.*
Sect. IV. *A Hundred Muscles requisite to Respiration.*
Sect. V. *Without Air the whole Structure is useless.*
Sect. VI. *The Properties of expanded Air.*
Sect. VII. *The Comparison of Respiration with Bellows.*
Sect. VIII. *An Experiment on the Lungs in* Vacuo.
Sect. IX. *An Experiment with a little Bottle of Water.*
Sect. X. *Experiment of a Syringe in* Vacuo.
Sect. XI. *Convictions from the foregoing Observations.*
Sect. XII. *The Use of Respiration.*
Sect. XIII. *The Disposition of the Air in time of Pestilence.*
Sect. XIV. *The Air leaves something in the Blood.*
Sect. XV. *Convictions from the foregoing Observations.*

CONTEMPLATION VIII. pag. 95

Of the Structure of the Veins.

Sect. I. *Transition to the Veins.*
Sect. II. *The Course of the Arteries.*
Sect. III. *The Course of the Veins.*
Sect. IV. *Convictions from both the foregoing Sections.*
Sect. V. *A rough Representation of the Circulation of the Veins.*
Sect. VI. *How often Blood Circulates in an Hour.*
Sect. VII. *Convictions from thence.*

Sect.

Sect. VIII. *Several Particulars*: 1. *Orifices of the Lateral Branches.*
Sect. IX. 2. *The Arteries grow Narrower.*
Sect. X. 3. *The Arteries contract themselves*
Sect. XI. 4. *The Pulse is not felt.*
Sect. XII. 5. *The Concurrence or Conjunction of the Nerves.*
Sect. XIII. 6. *The Division of the Arteries into Capillary Tubes.*
Sect. XIV. 7. *The Narrowness of the Tubes lessens the Swiftness of the Blood.*
Sect. XV. 8. *The Veins grow wider.*
Sect. XVI. 9. *The little Valves in the Veins.*
Sect. XVII. 10. *Of the Fibres in the Veins and Arteries.*
Sect. XVIII. *The Uses of the Blood in general.*
Sect. XIX. *The Enumeration of several Humours.*
Sect. XX. *The Passage of the Urine.*
Sect. XXI. *Of the Breasts of Women.*
Sect. XXII. *The Structure of the Seminal Vessels.*
Sect. XXIII. *Convictions from the foregoing Observations.*
Sect. XXIV. *The Nourishment and Motion of the Blood not yet fully known.*

CONTEMPLATION IX. *pag.* 131

Of the Nerves, and briefly of the Lymphatic Vessels, Glands and Membranes.

Sect. I. *Transition to the Nerves.*
Sect. II. *Different Opinions about the Matter passing thro' the Nerves.*
Sect. III. *An Experiment to prove a Nervous Juice.*
Sect. IV. *Convictions from the foregoing Observations; and an Experiment about Motion.*

Sect.

Sect. V. *The Nerves of Hearing are extended to the Tongue alſo.*
Sect. VI. *The Nerves of Taſting.*
Sect. VII. *Nerves that operate with, or without our Conſent*
Sect. VIII. *The* Par-vagum *and Intercoſtal Nerves.*
Sect. IX. *Convictions from the foregoing Obſervations.*
Sect. X. *The unhappy Condition of Atheiſts.*
Sect. XI. *The Nerves of the Midrif.*
Sect. XII. *The Nerves of the* Inteſtinum Rectum.
Sect. XIII. *The* Vaſa Lymphatica.
Sect. XIV. *The Glands.*
Sect. XV. *The Membranes.*
Sect. XVI. *The* Dura-Mater, *or thick Membrane of the Brain.*
Sect. XVII. *The Flexibility of the Membranes.*

CONTEMPLATION X. *pag.* 139

Of the Muſcles.

Sect. I. *Tranſition to the Muſcles.*
Sect. II. *Of the Muſcles in General.*
Sect. III. *Deſcription of the Muſcles.*
Sect. IV. *The Strength of the Muſcles conſiſts in their many Fibres*
Sect. V. *Double Muſcles.*
Sect. VI. *The Muſcles yet more doubled.*
Sect. VII. *The Muſcles of the Fingers.*
Sect. VIII. *Of the Joints.*
Sect. IX. *The Inſertion of the Tendons.*
Sect. X. *The Inſertion of the Tendons prevents all Inconveniencies.*
Sect. XI. *A Muſcle exerts a greater Force againſt a ſmaller Weight.*

Sect. XII. *Why a greater Force is used by the Muscles against a smaller Weight.*
Sect. XIII. *Convictions from the foregoing Observations.*
Sect. XIV. *The very great Strength of the Muscles.*
Sect. XV. *Convictions from thence.*
Sect. XVI. *Transition to the Demonstration of the Force of the Muscles.*
Sect. XVII *A Brief Demonstration of the Force of the Muscles.*
Sect. XVIII. *The Different Course of the Muscular Fibres.*
Sect. XIX. *Convictions from the foregoing Observations.*

CONTEMPLATION XI. *pag.* 195

Of the Bones.

Sect. I. *Transition to the Bones.*
Sect. II. *The Skull, and Bones of the Head.*
Sect. III. *The Back-bone.*
Sect. IV. *The Uses of the Structure of the Back-bone.*
Sect. V. *The* Vertebræ.
Sect. VI. *The Ribs.*
Sect. VII. *The Hip-bones.*
Sect. VIII. *The Thigh-bone.*
Sect. IX. *Of the Teeth.*
Sect. X. *Of the Bones in unborn Children.*
Sect. XI. *The Bones are produced from a fluid Matter.*
Sect. XII. *An Explanation of Psalm* cix. 18.
Sect. XIII. *Bones are without Nerves.*
Sect. XIV. *Of the Marrow.*
Sect. XV. *Water and Oyl together serve to render the Parts smooth.*

Sect.

Sect. XVI. *Oyl and Water ſo mingled ſerve to inſinuate themſelves into the Joynts.*
Sect. XVII. *Convictions from the foregoing Obſervations.*

CONTEMPLATION XII. *pag.* 214

Of the Sight.

Sect. I. *Tranſition to the Sight.*
Sect. II. *The External Structure of the Eye.*
Sect. III. *The Properties of Light.*
Sect. IV. *Concerning Refraction, &c.*
Sect. V. *An Experiment of Rays paſſing from Air into Water.*
Sect. VI. *An Experiment of the Refraction of Rays paſſing from Water into Air*
Sect. VII. *An Experiment to ſhew that the Rays falling at Right Angles are not Refracted.*
Sect. VIII. *Divergent Rays render'd Convergent, and do form an inverted Image.*
Sect. IX. *An Experiment to prove the ſame.*
Sect. X. *The Experiment of a* Dark Chamber.
Sect. XI. *Convictions from the foregoing Obſervations.*
Sect. XII. *The Eye is a Dark Chamber.*
Sect. XIII. *No Images from Divergent Rays.*
Sect. XIV. *The Tranſparency of the* Tunica Cornea.
Sect. XV. *The Aqueous Humour.*
Sect. XVI. *The Cryſtaline Humour.*
Sect. XVII. *The Vitreous Humour.*
Sect. XVIII. *How an Image is form'd in the Eye, and Convictions from the foregoing Obſervations.*
Sect. XIX. *Several Remarks: 1. That the Eye is Black within.*

Sect.

Sect. XX. 2. *That the Cryſtaline Humour is a Microſcope; and Convictions from thence.*
Sect. XXI. 3. *About ſeeing at ſeveral Diſtances; An Experiment upon it.*
Sect. XXII. 4. *About Opening and Shutting the Pupil or Black of the Eye, with an Experiment proving the ſame.*
Sect. XXIII. *Convictions from the foregoing Obſervations.*
Sect. XXIV. *The Sun neceſſary to Sight; and Convictions from all the foregoing Obſervations.*

CONTEMPLATION XIII. *pag.* 243

Of Hearing

Sect. I. *The Inſtruments of Hearing unknown.*
Sect. II. *But yet ſufficient to prove the Wiſdom of GOD.*
Sect. III. *The External Structure of the Ear.*
Sect. IV. *The Auditory Tube, and the Membrane called the Drum.*
Sect. V. *The Cavity call'd the Drum, the Bones of the Ear,* &c.
Sect. VI. *The Motions of the above-mentioned Inſtruments.*
Sect. VII. *The Openings in the Circumference of the Cavity of the Drum.*
Sect. VIII. *The Labyrinth,* &c.
Sect. IX. *The Auditory Nerves.*
Sect. X. *All the Inſtruments of Hearing ſhown.*
Sect. XI. *An Experiment proving that the Auditory Tube increaſes the Sound.*
Sect. XII. and XIII. *Sounds produce a Tremulous Motion in the Drum-Membrane,* &c. *prov'd by ſeveral Experiments.*

Sect.

Sect. XIV. *The Tremulous Motion of the Auditory Bones.*
Sect. XV. *The like Motion in the Membrane of the Labyrinth.*
Sect. XVI. *Convictions from some Particulars.*
Sect. XVII. *The Difference between the Instruments of Hearing in Young and Grown People.*
Sect. XVIII. *The Instruments of Hearing useless without Air; Convictions from thence.*
Sect. XIX. *The Nerves that are moved in Hearing.*
Sect. XX. *The Use of the Nervous Cord.*
Sect. XXI. *The Fifth Pair of Nerves, serve to excite the Passions.*
Sect. XXII. *The* Dura-Mater *produces the like Emotions.*
Sect. XXIII. *The Eighth Pair produces the same Effects.*
Sect. XXIV. *The Auditory Nerves produce the like Effect.*
Sect. XXV. *The Motion of the* Chorda Tympani *does also stir up the Passions.*
Sect. XXVI. *Why the Hearing above all other Senses is best adapted to these Purposes.*
Sect. XXVII. *An Experiment to shew the Power of Musick.*
Sect. XXVIII. *The Force of other Sounds.*

CONTEMPLATION XIV.

Of the Senses of Tasting, Smelling and Feeling.

Sect. I. *The Necessity of the Tast.*
Sect. II. *The Seat of Tasting is in the Mouth.*
Sect. III. *Several Opinions about the Instrument of Tasting.*
Sect. IV. *The Instruments of Tasting.*
Sect. V. and VI. *Experiments to shew that the Tast is in the Palate.*

Sect.

Sect. VII. *The Instruments of Smelling.*
Sect. VIII. *Convictions from the foregoing Observations.*
Sect. IX. *The Sense of Feeling.*
Sect. X. *The Instruments of Feeling.*
Sect. XI. *Convictions from the foregoing Observations.*
Sect. XII. *That the Fingers and Palms of the Hand have a more acute Sense of Feeling, than other Parts of the Body.*
Sect. XIII. *Convictions from what has been said concerning all the External Senses.*

CONTEMPLATION XV. *pag.* 289

Of the Union of the Soul and Body: And of the Imagination and Memory.

Sect. I. *The Union of the Soul and Body unknown to us: Convictions from thence.*
Sect. II. *The Bounds of this Union.*
Sect. III. *Convictions from thence.*
Sect. IV. *Of the Imagination and Memory.*

CONTEMPLATION XVI. *pag.* 294

Of the Humane Passions or Inclinations; and briefly of Procreation.

Sect. I. *The Passions and Inclinations.*
Sect. II. *The Difference or Disagreement of Passions and Inclinations.*
Sect. III. *The Agreement of the Inclinations and Passions.*
Sect. IV. *The Love of our Country.*

Sect.

The CONTENTS.

Sect. V. *The Contempt of Dangers.*
Sect. VI. *Convictions from the foregoing Observations.*
Sect. VII. *The Desire of Procreation.*
Sect. VIII. *Why we have not treated more fully and minutely upon the Business of Generation.*
Sect. IX. *The Principles* or Stamina *of Living Creatures.*
Sect. X. *Convictions from the foregoing Observations.*
Sect. XI. *Several Difficulties removed.*
Sect. XII. *Convictions from the foregoing Observations.*
Sect. XIII. *Transition to a Demonstration against Chance.*
Sect. XIV. *A Table of the Number of Males and Females Christen'd yearly in* London *for* 82 *Years.*
Sect. XV. *A Judgment upon the said Table.*
Sect. XVI. *The first Mathematical Demonstration, that the World is not governed by Chance.*
Sect. XVII. *The Difficulties and Objections that some may make against these Calculations, answered.*
Sect. XVIII. *A second and more accurate Mathematical Demonstration, that the World is not govern'd by Chance.*
Sect. XIX. *The Calculation after the common Manner.*
Sect. XX. *This tedious Calculation contracted.*
Sect. XXI. *Convictions from the foregoing Calculations.*
Sect. XXII. *Expression of the Number found, in common Words.*

N. B. The Twelfth *Contemplation* as it stands in the Original, and which wholly relates to certain Passages in the Scriptures, having been omitted in the Translation, for Reasons already given, as well as many Sections in other *Contemplations* on the like Account, has occasioned a great Difference between those of the Original and these published here.

ERRA-

ERRATA.

IN the *Postscript* of Mr. *Desaguliers*'s Letter, for *Journal*, &c. read *Nouvelles de la Republique des Lettres*.

In the Summary Account, &c.

p. iii, l. 31, r. *Powerful*.
p. iv, l. 23, r. procure.
p. v, l. 29, r. he must conclude.
p. vi, l. r. *Salival Glands*.
p. viii, l. 17. r. *Sphincter*. l. 32. r. *Chyle*.
p. xiii, l. 3, 4. for *and* r. *or*.
p. xv, l. ult. for *Perspective* r. *Prospective*.
p. xviii, l. 25. r. Dimensions.
p. xx, l. for *Graevesande* r. *s'Gravesande*.
p. xxi, l. ult. r. *Effect*.
p. xxvii, l. ult. for *deduces* r. *produces*.
p. xxxiii, l. 8. r. obliquely. l. 16. for *Distinguished* r. *Diminished*. l. for *Globula* r. *Globuli*. l. penult. r. Convex Glass.

In the Author's Epistle, l. 31, r. without any actual Experiment.

p. 220. l. 18. before *A. E.* r. *Rey*.



A Summary ACCOUNT OF Dr. *Nieuwentyt*'s BOOK; BY THE Ingenious Monſieur *Bernard*, &c.

PART I.

§. I. DR. *Nieuwentyt*, an Eminent *Philoſopher*, and Great *Geometrician*, propoſes to himſelf two Things in this excellent Work: The Firſt is, by the Contemplation of the Univerſe, to convince Atheiſts of the Exiſtence of a Supreme, All-powerful, All-wiſe, and All-good Being. The Second is, To eſtabliſh the Truth of that Divine Revelation we meet with in

the Scripture, againſt thoſe, who tho' they believe there is a God, do yet deny this Revelation. I queſtion, whether there be any intelligent, conſidering Perſon, free from Prejudice, who does not believe our Author has perfectly ſucceeded in the Firſt; but, perhaps, there may be ſome, who think he is leſs convincing in the Proofs he makes uſe of to eſtabliſh the Second. He draws theſe Proofs from the new Diſcoveries that are made in the Works of Nature; and he pretends, that theſe new Diſcoveries were known to the *Pen-men* of the Old and New Teſtament; and conſequently, that they were inſpired by the *Holy Ghoſt*: To this End he makes divers critical Remarks on the Paſſages he quotes, and has often Recourſe to the Original *Texts*, to find in theſe Paſſages a Senſe agreeing with theſe new Diſcoveries. The Method is New, and altogether Ingenious; but I fear the Author will not have the good Fortune to perſwade, becauſe his Reaſons here are leſs evident than thoſe which he alledges for eſtabliſhing his firſt Poſition.

An Objection might be raiſed, which I do not find anſwer'd in any thing I have hitherto read of his Book; for it may be asked, whether the *Jews*, for whom the Books were writ, apprehended the meaning *thus*, as Dr. *Nieuwentyt* quotes theſe Paſſages, or whether they did not apprehend them *thus*? If they apprehend them *thus*, how comes it that this Knowledge was not conveyed down even unto us? And why have the new *Philoſophers* given themſelves ſo much trouble, and made ſo many Experiments to diſcover theſe Things? If they did not apprehend them *thus*, of what uſe cou'd thoſe *Texts* of Scripture have been to them? They cannot be conſidered otherwiſe than as Foundation-Stones, which hitherto have been uſeleſs, till our Learned Author raiſed a Superſtructure on them. For theſe Reaſons, our View in this Extract, will be

be almoſt entirely confined to the firſt *Poſition*, which he has eſtabliſhed with ſo much Force and Evidence

§. II. After an Advertiſement to the *Reader*, you meet with a conſiderably long *Preface*, where the principal Cauſes of Incredulity are ſtated; and the principal Remedies that may be applied to each of them in particular enumerated. All that the *Author* ſays on this Subject, deſerves the reading; but in a Work ſo voluminous, one can hardly do more, than point out the principal Matters: I ſhall therefore only obſerve on his Preface, that the Syſtem of *Spinoſa* appears to me to be there entirely overthrown; he ſhews us that it is altogether eſtabliſhed on arbitraty *Definitions*, which very well expreſs the *Ideas* that this *Atheiſt* forms to himſelf, and from which may be drawn Conſequences, ſuitable to ſuch *Ideas* and *Definitions*; but that he no where proves, that there is any Thing really exiſting out of himſelf, wherewith the *Ideas* and *Definitions* which he forges, do correſpond; inſomuch, that *Plato*'s Republick, or Sir *Thomas More*'s Utopia, have ſomething more of Reality in them, than the whole Syſtem of *Spinoſa*.

§. III. The Work is divided into Thirty *Contemplations*, in which our Learned *Author* has collected all the new Diſcoveries made by others on the Works of Nature, as well as thoſe he has made himſelf; and he concludes from each in particular, that it manifeſts the Author to be infinitely Powerfully Wiſe and Good, who hath created the World, and all the Beings of which it conſiſts; that he hath made all theſe Beings for certain Ends, and that they all anſwer perfectly well the Ends for which he created them.

1. He begins the Firſt *Contemplation*, by conſidering Man in General: He ſhews, that this Crea-

ture would be moſt unhappy, unleſs he were ſufficiently aſſured of the Exiſtence of a Supreme Being, who is the *Author* of all Events, and that nothing can happen without his wiſe Providence. This Creature knows full well, that he did not make himſelf, and that as he hath a Beginning, ſo alſo he muſt have an End; that he can neither prevent his Death, nor delay its Coming even one ſingle Moment, his Life being continually expoſed to a thouſand Accidents. If he holds out to an extreme old Age, the Inconveniences which attend that State, creep upon him daily; his decaying *Eyes* ſcarce perform their Functions of ſeeing, his *Hearing* fails, there is ſcarce a *Tooth* left in his Head, and his *Legs* can hardly ſupport his feeble Body. The *Author* repreſents the other Misfortunes of Life with a great deal of Energy; he ſhews, that they who attribute all Things either to *Chance*, or *blind Fate*, can never enjoy the leaſt Security; are they in Proſperity, they cannot count upon its Duration; are they in Adverſity, they know not when, or whether ever, it will end. There is nothing can procure a Man the leaſt ſolid Quiet, but a firm Perſuaſion of the Exiſtence of a gracious *God*, who governs and directs all Things.

2. This Creature, *Man*, conſidered by himſelf in Particular, and compared with all viſible Objects in General, is the Subject of the Second *Contemplation*: He is compoſed of a Body incapable of Thought, and a Soul endued with a Power of thinking, judging, willing, and reaſoning; as he is ſure that he made not himſelf, ſo is he alſo ſure that he received not his Being from his *Parents*, as the true Cauſe thereof; for theſe *Parents* themſelves did not know what this Creature, which they were about to bring into the World, was, of what it was compoſed, or whether it would prove a Male or Female. Every Thing that acts without Foreſight, or a Conſciouſneſs of what it is going to effect,

effect, can be conſidered no otherwiſe than as the *inſtrumental Cauſe* of what it produces.

As this Creature, *Man*, does neither give Being to himſelf, nor has received it from his Parents, ſo neither can he nor his Parents be the Authors of his Preſervation; they can neither make the Sun riſe or ſet, they cannot ſo much as produce one drop of Rain to make the Earth fertile, or to furniſh themſelves with Drink, which is ſo neceſſary to them; they cannot ſo much as make the leaſt Plant, no, nor one ſingle Grain of Corn to grow. And when this Creature, *Man*, is provided with all theſe Things, does he know at all, how they contribute to the Nouriſhment and Preſervation of his Body? How theſe Aliments change themſelves into *Blood*, *Lymph*, &c. How they are blended in the proper Parts of the Body, into *Fibres*, *Veins*, *Arteries*, *Nerves*, *Bones*, &c. All this is out of his Power; all this proves, that he neither owes his Preſervation to himſelf or Parents, but to another *Being*. Can this Creature, *Man*, therefore live in any quiet, without knowing the *Author* of his Being, and of his Preſervation? This *Being* muſt neceſſarily be an intelligent *Being*, that knows what he does, and why he does it: After the ſame manner, if you ſhow any Body ſeveral *Clocks* curiouſly made, and regularly placed in a Chamber, all which exactly point out, and inform him of the Hours, *&c.* he would conclude, that it was an ingenious, experienced *Artificer*, who contrived thoſe *Machines*.

After theſe general Reflections, Dr. *Nieuwentyt* enters on Particulars; and in the thirteen Contemplations following, he runs thro' the particular Parts of humane Body, and the five different Manners of Senſation; and he makes appear, that there is ſo much Contrivance, and ſo many different Deſigns, in all theſe things, that he who attributes them, either to blind *Chance*, or a *Fatal Neceſſity*, muſt be

ſtupid and Senſleſs. Not to follow our learned *Author* cloſely, (for then we ought to copy him entirely) let us content our ſelves with ſome ſelect Remarks.

Why are all the Bones in a humane Body, except the *Teeth*, encompaſſed with a *Perioſteum*, or a Membrane exquiſitely ſenſible? Who ſees not the Reaſon of this! becauſe the Teeth are appropriated to break, and grind the Food, which Office they could not be made to perform, were they ſurrounded with that Membrane, without ſuffering the moſt violent Torment. 'Tis known, that Bones diveſted of that Membrane (or the *Perioſteum*) and expoſed to the Air, are preſently ſpoiled. But here, inſtead of ſuch a Membrane, God has armed the Teeth with an Enammel, which guards them from the Injuries of the Air. The *Lips* and the *Tongue* are yet more wonderful than the *Teeth*; the *Lips* open to receive the Drink and Meat, and then cloſe themſelves again, leſt, in chewing, the Food ſhould fall out; they are ſo formed, as to afford Infants the Means to ſuck Milk from the Breaſts of their Mother. There are in the Jaws divers *Saliviate Glands*, out of which, whilſt the Meat is chewing, there ouzes, as from a Fountain, a liquid Juice, which moiſtens the Food, thereby rendering its Paſſage, by the *Pharynx* and *Oeſophagus* into the Stomach more eaſy, and helps to diſſolve it there into a liquid Subſtance.

The *Tongue* is formed exactly in the Manner it ought, not only for adjuſting the Food in the Mouth, and directing its Paſſage into the *Oeſophagus*, but alſo, by great Variety of different Movements, of which it is ſuſceptible, for pronouncing the infinite Number of Words in all Languages, by which Men communicate their Thoughts ſo eaſily to one another. Can we think, if we conſider what Difficulty we ſhould have to converſe together, and how hard 'twould be to communicate our Thoughts without Speech, that all this is done with no Deſign! The

Example

Example of Men deaf and dumb, who with greateſt Difficulty are made to apprehend the Meaning of others, ſufficiently demonſtrates into what Inconveniencies we ſhould be brought, if we could not ſpeak to one another. The *Tongue* has yet another Uſe, it is the Principal Organ of *Taſt*, which cauſes us to take Pleaſure in the Uſe of our Food, ſo neceſſary towards our Subſiſtance; a Pleaſure, without which we ſhould ſcarce have any Appetite to our Victuals; altho' our Life abſolutely depends on Eating.

Certainly it can never be by Chance, that the *Pharynx* and *Oeſophagus* are ſo well adapted to convey Food from the Mouth into the Stomach; nor that the *Epiglottis* is placed at the Entrance of the *Throat*, cloſing it ſelf exactly when any thing is ſwallowed, leſt it ſhould get into the *Tracheal Paſſage*, which never happens without the ſucceeding Torment of a violent Cough, and the Danger of being choaked.

The Manner of our receiving *Air* into the *Lungs*, and the Way that *Infants* (and many other Animals) ſuck Milk from their Mother, immediately after their Birth, ought likewiſe to incite in us an Admiration of the Wiſdom of the *Creator*. The Mouth, and the other Parts, which ſerve, either for Reſpiration or Suction, do then become a perfect *Pneumatick Engine* (or *Air Pump*); which cannot otherwiſe be accounted for, than by allowing the Gravity and Elaſticity of the Air; and yet Men who breath, and Children that ſuck, are ignorant of this Cauſe, which can be attributed to nothing elſe, but to the Omniſcience and infinite Wiſdom of the *Creator*. This is (ſays our *Author*) what *David* means, in the 8th *Pſalm*, when he ſays, that *God* has, *out of the Mouth of Babes and Sucklings, ordained Strength, becauſe of* his *Enemies*. The *Author* demonſtrates the admirable Frame of the *Stomach* (or *Ventricle*), as well for receiving the Aliments, and keeping them there 'till they are di-

geſted, and afterwards conveying them into the *Inteſtines*, as for exciting in us the Senſe of Hunger, without which, we ſhould not be put in mind of the Neceſſity of Food, or think of taking it in due Seaſon. The Inteſtines are another marvellous Effect of the Wiſdom of God; their Connexion with the *Meſentery*, their Length, their different Thickneſs, the different Windings that they have in the lower Part of the Belly to detain the Food there, a conſiderable Time, their Communication with the *Lacteal Veins*, to which they afford Chyle ready prepared, their *Periſtaltick* Motion, determined by the Contraction of the *Fibres* downwards, their *Antiperiſtaltick* Motion, by the Contraction of the *Fibres* upwards, the voluntary Power of moving the *Anus*, ſo that it ſhall at pleaſure either open or ſhut by the Means of the *Sphyncter Muſcles*, and thereby hinder an involuntary Eſcape of Excrements from the Body, at the ſame time when ſo many other Movements in this *Machine* of ours cannot be govern'd by our Will; all theſe, and many other Circumſtances, which one might add, can never be the Work of CHANCE; and he muſt be very blind who does not ſee thereby, that theſe are the Effects of an *All-wiſe* OMNISCIENCE, who hath made them for the Uſes in which we ſee they are actually employed.

The Separation of the *Chyle* from the *Excrements*; the *Valves* which open a Paſſage for it into the *Lacteal Veins*, at the ſame Time hindering the *Chyle* from returning back into the *Inteſtines*;) the Mixture of the *Chyle* with a Humour diſtilling from the *Lymphatick Ducts* into the *Receptaculum Chili*, found out by *Pecquet*, for rendring the *Chyle* more fluid; beſides other Valves which manifeſt themſelves in ſeveral Places, as the *Chyle* aſcends in its Paſſage towards the *Heart*, (which Valves ſuffer the *Chyle* to aſcend, *towards the Heart*, but by no means permit it to deſcend, as otherwiſe it naturally muſt by its own Weight;) the Means that Providence has ordained

dained for the Aſcenſion of this Liquor, by placing *Arteries* ſo near its Channel, that their Pulſation preſſes the *Ductus Chiliferus*, and by conſequence puſhes forward the *Chyle* contained in it; its emptying itſelf into the Blood at the *Left Subclavian*, to flow in Conjunction with it through the deſcending Trunk of the *Vena Cava*, into the Right Ventricle of the Heart, to the end that the Heart may be ſupplied with proper Matter to form into new Blood; all theſe furniſh Dr. *Nieuwentyt* with ſo many ſeveral Proofs of the Exiſtence of a *Being*, ſovereignly wiſe, who is the Author of the Univerſe.

The wonderful Configuration of the *Heart*, of which he gives us an exact Deſcription in his Sixth *Contemplation*, furniſhes him with Arguments of no leſs Force. We only remark from thence, that the aſcending and deſcending Trunks of the *Vena Cava* meet one another near the *Heart*; therefore the Blood, which deſcends by the deſcending Trunk, meeting with the Blood which aſcends, ought naturally, by its Gravity, to put a ſtop to its Aſcenſion, which would prove an inſuperable Obſtacle to the Circulation of the Blood. To remove this Inconvenience, there is, at the Entrance where theſe two Trunks meet, a little Eminence made by the ſurrounding Fat; the Blood deſcending by the deſcending Trunk, ſtriking againſt this Eminence, is reflected on one Side, towards the Right Ventricle of the Heart, into which 'tis diſcharged. The ſame thing happens to the Blood aſcending by the other Trunk.

We have told you with what wonderful Contrivance the *Air* is introduced into, and expelled out of the *Lungs*: There is no one ignorant how neceſſary this Air is to humane Life: How comes it then that *Man* finds himſelf placed in a vaſt Ocean of this Fluid, like Fiſhes in the main Sea? If this Air be corrupted, it becomes mortal to this very Creature, without his being able, by all his Induſtry,

duſtry, to find out a Remedy: How comes it then that this Misfortune happens ſo rarely, there being ſo many Ways by which the Air may be corrupted? No other Cauſe can be alledged than the Care of a wiſe *Providence*.

The Circulation of the Blood in the Body, by which Means there is not a ſingle Portion of the whole Body which does not thence receive the Nouriſhment neceſſary for it; the Arteries and Veins, with their Glands, the Means by which the Blood, coming from the Heart into the Arteries, paſſes from thence into the Veins, and returns by the ſame Veins to the Heart: All this, proves an infinite Wiſdom in Him who formed this Body.

Dr. *Nieuwentyt* excites an Admiration of the Goodneſs of God, by conſidering, that altho' the *Pulſe* beats in infinite Parts of the Body, yet a Perſon in good Health, is not ſenſible of this Pulſation, which would be very inconvenient to him; as it is but too well known to Perſons afflicted with Sickneſs, who experience that Inconveniency to their no ſmall Grief. By the way it may be obſerved, that it is not by *Chance*, that the great *Artery* (call'd the *Aorta*) ſpreading forth its Ramifications thro' all Parts of the Body, (the Lungs only excepted) has not one ſingle Branch which is not exactly anſwered by the Branch of ſome Vein, which receives the Blood it brings, and carries it back to the *Heart*.

The ſame may be ſaid of the *Veſica* (or Bladder, the Receptacle of the Urine) as has been ſaid of the *Anus*; for how great an Inconvenience would it be, if the Urine ſhould paſs from us, every Time, againſt our Conſent? But to prevent this, the Author of Nature has placed a Muſcle, call'd the *Sphincter-Muſcle*, which being very ſtrong, ſtops the Paſſage, and has entirely ſubjected the Motion thereof to our Will; ſo as either to retain or diſcharge the Urine as we find convenient. And becauſe that Humour is compoſed of an exceeding great Number

ber of ſaline Particles, which by their Acrimony would be apt to excoriate the interior Tunicle of the Bladder, which is a Membrane extremely ſenſible, and which being hurt wou'd affect us with the moſt exquiſite Pain; to remedy this, therefore, there is a Lining of Fat, and mucilaginous Matter, which hinders theſe ſaline Particles from exerciſing their corroding Quality here.

The Cauſe of the Motions of the *Nerves* and *Muſcles* is not, even yet, thoroughly known; but their Structure, and Uſe, are Subjects of ſufficient Admiration to all who have any Knowledge of them. Our Author will by no Means allow *Animal Spirits*, or a *ſubtile Flatus*, paſſing from the Brain to the Nerves, to be the Cauſe of their Motion; but a *Succus Nutritius*, or nervous Juice; and he cites ſome Experiments that ſeem to confirm his Opinion. Thoſe *Nerves* and *Muſcles*, which ſerve to the Preſervation of our Life, have their Motion independent on our Will; inſomuch, that neither our Life nor Death, are in our own Power; on the contrary, we can eaſily move thoſe which are decreed to ſerve in Actions determinable by our Will, and ſuch as anſwer the End of our Creation. There are certain Parts of our Body endued with both a voluntary and an involuntary Motion; theſe are the Parts ſerving for Reſpiration; for we can hinder the Motion of the *Lungs*, &c. for ſome Time, if we pleaſe: But if the Motion of theſe Parts had been abſolutely, and altogether voluntary, all our Time would have been taken up about the Buſineſs of *Inſpiration* and *Reſpiration*, and we ſhould never have been able, in the mean time, to ſleep. But to prevent ſo great an Inconvenience, *Reſpiration* is performed whilſt we ſleep, without waiting preciſely on the Motions of our *Will*. Our *Author* has not forgot the extraordinary Force of the *Muſcles*, which altho' compoſed of fleſhly Fibres, exceeding fine, and which ſeem capable of breaking very eaſily, yet he makes appear, not only by abridg-

ing

ing what the learned *Borelli* has ſaid on the Subject, but alſo by ſeveral *Geometrical* Demonſtrations, the extraordinary Force of ſome of the principal *Muſcles* in humane Body.

The *Bones*, which are a remarkable Part of Man's Body, merit alſo our Attention, and demonſtrate the great Wiſdom of the *Creator*; without theſe, Man would only be a Maſs of ſoft Fleſh, which would be neither able to move or ſupport itſelf: The Manner how they are tied to one another, and joyned together, according to the different Uſes for which they are deſigned, is a plain Demonſtration, that all this could not be the Effect of *Chance*. Why are the *Spinal Bones* ſo artfully inſerted the one within the other, and of ſo hard a Subſtance? Why are their hollow Parts placed exactly oppoſite to one another, to make way for the *Spinal Marrow* (a Continuation of the *Cerebellum*, or *Medullary Subſtance*) which they cloſely conſerve and guard? Why are the Cavities in the *Bones* of the Head ſo large near the *Ears*, a thing which appears to be abſolutely neceſſary to make way for the Paſſage of the Air, moving through thoſe Orifices, when Sounds are conveyed to the *Tympanum*, by this means forming the Senſe of Hearing? Can all this be without Deſign, and yet, at the ſame Time, anſwer ſo directly to the Uſes we ſee them employed in?

The *Eye* has always paſſed for a Miracle of Nature; and the more we diſcover of its Structure, the more it affords us Subject of Admiration. The three *Humours* of the *Eye*, which have each their different Denſity, ought preciſely to be as they are, to the end that the *Rays*, which come from each Point of the *Object*, and which enter the *Eye* by the Pupil, (or *Apple*, as 'tis call'd) ſhould be differently refracted in paſſing through theſe three different Humours, uniting themſelves on the immediate *Organ* of Viſion, whether it be the *Choroides* or *Tunica Retina*. The *Pupilla* is not always of the ſame Bigneſs, it contracts

contracts or enlarges itſelf according to the Diſtance of the Object that is looked at. As for Example, when the Object is near and much enlighten'd, the *Pupilla* contracts itſelf; but when far off, and but little enlighten'd, it dilates itſelf. The *Eye* (all Parts taken together) is not an immoveable *Organ*; for by the Means of four direct Muſcles, 'tis either lifted up or let down, turned on one Side or other, juſt as the Objects, that it looks at, are placed, whether high or low, on this Side or that; otherwiſe we ſhould be always, at every Turn, put to the trouble of moving the whole *Head*. All the Parts of the Bottom of the *Eye* are black; to the end that when the *Rays* fall there, they may be abſorbed; for if they were reflected there, they muſt be mingled with the Rays which imprint the Image of the Object on the *Retina*, and this would render the painted Image confuſed; as in the *Camera Obſcura*, of which not the leaſt Part muſt receive Light, ſo as to admit *Rays* upon the white Paper, or Cloth, on which the Images of external Objects are painted.

The *Eye* is an admirable *Organ* both in reſpect of its Configuration, and the Effects produced by ſuch a Structure; but it is yet more wonderful in the Service it affords the Creature for whoſe Uſe it is ordained: For what muſt have become of *Man*, or indeed of any other Creature, if Nature had left them without Sight; or, if having Sight, they were not placed in the midſt of an Ocean, as it were, of Light which ſurrounds them; or, laſt of all, if this Light had not the Faculty of being refracted in its Paſſage from one *Medium* to another. 'Tis hard to comprehend the Miſery that Animals, thus doomed to Darkneſs, muſt neceſſarily undergo; and no queſtion but in a ſhort Time they would inevitably periſh, being deprived of Viſion, or the Faculty of Seeing. It muſt then be concluded, that *Light* was made for the *Eye*, and the *Eye* for thoſe Creatures

to

to whom it appertains: Is it not then the higheſt Piece of Folly imaginable, to ſay that all this comes by *Chance?*

The *Ear* is an Organ, which is yet perhaps more wonderful than the *Eye*; it is compoſed of a greater number of Parts, and more differing from one another, all of which have their peculiar Figure, Situation and Uſe, and all of 'em neceſſary to make us comprehend different Sounds. Moreover, the Senſe of Hearing is almoſt of as great Neceſſity and Uſe in humane Life, as that of Seeing; inſomuch that many Perſons had rather be *Blind* than *Deaf*: For to ſay nothing of the Charms of *Muſick*, and its ſurprizing Power to raiſe or aſſwage the *Paſſions*, what Difficulties ſhou'd we be put to, to convey our Thoughts to one another, and to make known our Wants, if we could not be heard or underſtood by each other.

This may be judged of by the Difficulty we perceive a Perſon put to in a ſtrange Country, where no Body underſtands his Language, and he is utterly unskilled in theirs. We have already ſpoke here of the Neceſſity of *Taſt*, in diſcourſing of the *Tongue*, which is the principal *Organ* of that *Senſe*: This *Senſe* makes us an agreeable amends for the Pain and Trouble we are put to in eating: This is particularly the Subject Matter of the Fifteenth *Contemplation* of our Learned *Author*, where he ſpeaks alſo of the *Smell* and *Taſt*; in ſaying, that the *Tongue* is the principal Organ of Taſt, we do not affirm it to be the only Organ of that Senſe, for the *Palate* muſt alſo there come in for a ſhare.

This appears by the tryal on a young *Lad* of eight Years old at *Poitou*, who having by the *Small-Pox* loſt his whole *Tongue*, cou'd yet diſtinguiſh very well the Taſt of different Victuals.

The *Smell* does not appear to be ſo neceſſary as the *Taſt*, it is nevertheleſs of great Uſe; and this Organ ſeems to have been placed juſt above the Mouth,

Mouth, that by the Scent we may be able to judge of the Nature of the Food, before we ſuffer it to enter our Mouths. And that which likewiſe further proves, that it is an infinite wiſe *Being*, who is the *Author* both of *Man*, and the Bodies which ſurround him, is that thoſe very Bodies in which we can conceive nothing but *Matter* and *Motion*, do produce ſuch different Effects on us, according as they act on different Organs, on which, in reality, they can produce nothing but Motion. * " Take, " for Example, a bit of *Sugar*, touch it, you per- " ceive it cold and hard; look at it, you ſee it " white, and of a certain Shape; ſtrike it with " another hard Body, you hear a Sound; put it to " your Noſe, you have a Scent; taſte it, you per- " ceive Sweetneſs: How does a ſingle Body which " appears ſo ſimple, and which can excite nothing " but Motion in our Organs, cauſe ſo different, " and at the ſame time ſuch uſeful Senſations! Is " not this the Work of a *Being* perfectly good and " wiſe, who has made and directed all theſe Things " for our Advantage."

'Tis objected, that our *Senſes* are imperfect; but this which ſome ignorantly call Imperfection, is an effect of the Wiſdom of the Creator, as our Author ſhews; for ſuppoſing our Eyes made like *Microſcopes*, we ſhould ſee, it is true, a great many *Objects* which we cannot now perceive with the naked Eye; but then we ſhould ſee at once but a very ſmall number of *Objects*.

And thoſe Minute *Objects* which wou'd be then manifeſted to our Sight (the ſeeing of which wou'd be but of little uſe to us) wou'd certainly hinder us from perceiving *Objects* which we ought, for our Preſervation neceſſarily to ſee. If our *Eyes* were made like *Teleſcopes* (or *Perſpective-Glaſſes*) we

* This is added by Monſ. *Bernard*.

ſhould

ſhould ſpy out ſeveral *Objects* at a diſtance, which when ſeen, wou'd be but of little ſervice to us; and at the ſame time we ſhould loſe the Faculty of ſeeing the *Objects* that are very near us, the loſs of which wou'd be inſupportable, becauſe theſe are the only *Objects* that can do us good or harm.

If our *Smelling* were as exquiſitely fine, as that of a *Hunting-Hound*, we cou'd not go a ſtep without being offended by the Effluvia of Bodies that ſurround us: This wou'd be a perpetual Trouble to us, in taking up almoſt all our Thoughts, and fixing them ſo on theſe ſcented *Objects*, that we ſhould ſcarce be able to mind any thing elſe.

If our *Taſt* were ſo delicate as to be affected as ſenſibly with Things which have the leaſt Reliſh, as we find it is at preſent by Things of a ſtrong, bitter, or acrid Savour, we ſhou'd be deprived of the uſe of the moſt part of that neceſſary *Food* which we take with Pleaſure, becauſe it would then be inſupportable to us.

If the *Organs* of *Hearing* were to be as much affected by every Noiſe, as they are when a *Trumpet* is ſounded at the *Ear*, or an *Otacouſtick* placed there to augment the Sound, we ſhould always be tormented with as great a Noiſe, as if we were in the midſt of a *Market*, or a thouſand People were bawling or talking all together; and we ſhou'd ſoon be ſtruck *Deaf*.

If every part of our Body were ſo exquiſitely ſenſible, as thoſe *Membranes* that cover the *Eye*, we ſhou'd endure from the touch of the leaſt *Mote* or *Atome* perpetual Pain, and we could therefore never reſt in any Place.

In the Sixteenth *Contemplation*, our *Author* examines the Union of the *Soul* with the *Body*, as alſo the Seat of *Imagination*, and the *Memory*: Theſe are three *Articles* which hitherto no *Philoſopher* has been able to explain, yet they are ſo worthy to be admired, that nothing leſs than an infinitely wiſe

BEING,

BEING, as Mr. *Nieuwentyt* very well obſerves, cou'd be the *Author* of them.

In the following *Contemplation*, he ſpeaks of the *Paſſions* of *Man*, and makes ſome Remarks on the Means GOD has made uſe of to continue Humankind by *Propagation*. If we examine the *Paſſions*, we find them ſo well diſpoſed for the Preſervation of *Mankind*, to avoid the *Evil* that threatens us, and to attain the *Good* we want, that it is the reaſonableſt Thing in the World to believe, that all this has been ſo ordered by an infinitely wiſe *Author*.

It ought alſo to be conſidered, that tho' *Men* reſemble one another exceedingly, as to their *Bodies*, and are fed with Aliments of much the ſame Nature; yet GOD has given to every one a particular Talent, each differing in Inclinations and Parts from one another: This induces one *Man* to betake himſelf to *Sciences*, another to *Traffick*, another to *Liberal Arts*, another to *Mechanical*: This is the Reaſon that all Men reciprocally ſtand in need of one another, and are excited to make a mutual Exchange of the Fruit of their Labours. From hence it proceeds, on one hand, that every one can have whatever he ſtands in need of for the Conveniencies of Life; and, on the other, that there is a mutual Commerce amongſt Men, which is the Band of Civil Society.

As to the *Propagation* of the *Species*, there reſults from thence ſo many different Pains and Inconveniences, as well to one Sex as the other (even to *Beaſts* as well as *Men*) that each *Race* you'd ſoon be ended, if GOD had not provided a Means to ſurmount all theſe Troubles and Difficulties, by the Pleaſure which he has annexed to this Buſineſs, and by the Inſtinct he has implanted in all *Animals*, which makes them undergo with Delight the Pains they are at in rearing thoſe of their own *Kind*, which they bring into the World. The *Hand* of

Providence is ſo remarkable herein, that he who does not perceive, and acknowledge it, muſt be altogether ſtupid.

There is yet another amazing Inſtance of the *Wiſdom* of the CREATOR, which is a *Mechanical* Love (if one may call it ſo) that a Man has for the *Country* in which he was *born*, how much ſoever that *Country* be out of Favour with Nature, or whatever Inconveniencies one undergoes there. If it were not for this, more than one half of the habitable *World* would be left deſtitute of *People*; all Men wou'd be for getting to the better *Country*; and in order to ſettle themſelves there, they would be continually thruſting one another out.

Our Learned *Author*, omiting every Circumſtance which does not carry with it certain Evidence, with reſpect to the *Propagation* of the *Species*, does not forget to remark, that every *Individual* of each *Species*, as well of *Plants* as *Animals*, is found in the Seed from which it ſprings; and all their Parts are there diſtinguiſhed from one another, tho' theſe little *Seeds* do not ſometimes exceed the Demenſions of one Grain of *Sand*: Hence it muſt be ſuppoſed, that every Part of each of theſe Individuals, is in the *Stamen*, or *Seminal Subſtance*, of a Minuteneſs which exceeds Imagination; and which is, in ſome ſort, diviſible *ad infinitum*.

The *Unfolding*, or Opening of all theſe *Parts*; the Manner of their *Growing*, one becoming hard at the ſame time whilſt the other remains ſoft; all this cou'd not ſo fall out by *Chance*, but muſt be the Effect of a perfectly *wiſe* AGENT.

On this Occaſion our *Author* gives us a *Regiſter* of the Number of *Males* and *Females* which have been born in *LONDON* every Year, for theſe eighty two Years paſt, *viz.* from the Year 1629, to the Year 1710. It appears by this *Regiſter*, that there are always more *Males* born than *Females*: The leaſt dif-

difference was that of the Year 1703, in which there was born 7765 *Males*, and 7683 *Females*. The greateſt difference was in the Year 1661, when there was born 6128 *Males*, and but 5301 *Females*. The *Author* makes on this Subject divers Reflections, which are ſuch as he either borrows from the Experience of others, or what he gives us on his own Credit: He remarks, that altho' Breeding and Child-Bed carries off many *Women*; nevertheleſs, the Number of *Men* which are loſt at *Sea*, and kill'd by *Land*, in the Wars, as well as thoſe that die by Fatigues, hard Labour, and ſeveral Accidents, exceeds the Number of *Women* dying each Year: It follows therefore, that the *Author* of *Nature* has been pleaſed to provide againſt this Inconvenience, and has taken care that each *Woman* may have a *Husband*, by cauſing a greater Number of *Males* to be born than *Females*; a Thing which cannot poſſibly be attributed to CHANCE. * "For if a DIE, which is a perfect *Cube*, having each of its Sides marked with one of the firſt ſix Numbers, be caſt, it will be impoſſible that the greateſt Numbers, *viz.* 4, 5 and 6, ſhould always infallibly come uppermoſt." It follows therefore, from this very Remark, that *Polygamy* is contrary to the *Law of Nature*; becauſe, that he who is the *Author of Nature* hath ſo order'd Matters, that by abſtracting the greater Number of *Males* which Death carries off Yearly, there ſhould remain about an equal Number of both Sexes.

To give this *Demonſtration* all the Evidence it ought to carry along with it, methinks ſome Obſervations ſhou'd be made in Relation to other *Animals*: For if there be found ſome ſort of Creatures, beſides *Men*, amongſt which there is a kind of *Marriage*, there ought to be an equal Number,

* This is added by Mr. *Bernard*.

or the *Argument* will not hold good: But one Cock ſerves many *Hens*; one *Bull* many *Cows*; one *Stallion* ſeveral *Mares*. Now, it ſeems, if there is to be found amongſt theſe *Animals* the ſame Proportion, as to *Males* and *Females*, that is obſervable in *Mankind*, the Argument muſt loſe much of its Force. On the contrary, it wou'd very much fortify our Author's Reaſons, if among theſe ſorts of *Animals*, where one *Male* ſuffices a great many *Females*, there ſhould be a far greater Number of *Females* brought into the World than *Males*: In particular, I believe it will be found, that there is as great a Number, if not greater, of *Cocks* as of *Hens*: In reſpect of *Pigeons*, amongſt which there is a *kind* of *Marriage*, I believe that it will appear experimentally true, that there are hatched very near as many *Males* as *Females*: In a word, we have not ſufficient Experience, in my Opinion, in this Matter, to affirm any thing peremptorily about it.

The Ingenious Monſ. *Graeveſandt*, Profeſſor of the Mathematicks at *Leyden*, has taken the Pains to compute what Odds it is to One, that this which we have taken notice of, about ſo many more *Males* being born, for theſe eighty two Years paſt, in *London*, than *Females*, wou'd not come to paſs if it were left wholly to *Chance*; and he proves the Odds to be prodigious, *viz.* 75, 598, 215, 229, 552, 469, 135, 802, 469, 135, 802, 469, 135, 802, 469 to One: We muſt ſtop here: A *Work* of this Importance requires to be treated of further in another Place. The Diviſion will prove natural enough, conſidering, that in what is to follow he treats of other *Beings* in *Nature*, and has done now with ſpeaking particularly of *Man*.

Part II.

THE first Seventeen *Contemplations* of Dr. *Nieuwentyt*, an Account of which is extant in our *Nouvelles* for the Months of *March* and *April*, peculiarly respecting Man: In the following *Contemplations* he makes a Transition to the other principal Parts of the *Universe*.

1. The subject Matter of the Eighteenth *Contemplation* is Air; here he explains the principal Properties of this Fluid, as the *Gravity* and Elasticity of it; and this he proves by *Experiments*, the most of which are now very well known to the *learned World*: He makes appear, that not only *Men*, but also *Beasts*, and even *Plants*, &c. are absolutely indebted to this *Air* for their Life.

For Example; 'tis demonstrable, that a small Quantity of *Air*, shut up in the *Lungs* of an *Animal*, or enclosed within the Walls of a *Chamber*, counterballances the whole Exterior *Atmosphere* of ambient *Air*; so that the Resistance of any Part of the *Air* is equal to the Pressure of all the rest: Without this necessary *Law* of *Nature*, *Animals* cou'd not be able to preserve themselves alive; the Windows of a *Chamber*, by the Pressure of the external *Air*, wou'd be broken Inwards; the *Tents* of any *Army*, the *Huts* of *Peasants*, and many other more considerable *Buildings*, cou'd not bear the unequal Pressure of the *Atmosphere*, nor continue standing, if the Pressure from without were greater than the Resistance of the *Air* from within; now all this can never be the *Effects* of *Chance*.

Without AIR *Plants* cou'd neither live nor grow; 'tis *Air* which preſerves *Fire* from going out, and makes *Smoak* aſcend, whereby the Inconveniencies thereof are prevented. Without *Air* there cou'd be no *Sound*; and conſequently Men cou'd not communicate their Thoughts by Speech; and we ſhou'd be deprived of all other Advantages, which are the Effects of *Hearing*. Without the Weight of the *Air*, no fermenting Liquor cou'd be contained in any Veſſel; boiling *Water*, or even *Water* made a little warm, wou'd run over the Veſſel that contained it. It is by the Means of *Air* that the Refractions of *Light* (or *Twilight*) is cauſed; and thereby the tedious Length of the *Nights*, which thoſe who live near the *Poles* are forced to endure, is ſhortned. The ſame *Air* cauſes us to ſee *Light*, and even the SUN it ſelf before it riſes above the *Horizon*. Dr. *Nieuwentyt* believes that it is concerning the *Preſſure* of the *Air*, which has been diſcover'd to us only this laſt AGE, that *Job* ſpeaks when he ſays, —— * *Make the Weight for the Winds.*

2. Our *Author* treats of *Meteors* in his Nineteenth *Contemplation*, where a great Number of *Experiments* are related. 'Tis manifeſt, that there are perpetually Vapours and Exhalations in abundance riſing from the *Earth*, the *Nature* and *Quality* of which are as various as the infinite Numbers of *Bodies* from whence they are exhaled. Among theſe Vapours and Exhalations, there are ſome wholeſome and uſeful to *Man*, *Beaſts* and *Plants*; and there are others hurtful and poiſonous; all theſe mix, and are jumbled together, and from ſuch Mixture reſults an Infinity of differing Compoſitions.

We have made appear, that *Animals* and *Vegetables* are indebted to this ſame AIR for their Life: But how

* *Job*, Chap. xxviii. ver. 25.

how comes it to paſs, if there be no Providence, that this ſame marvelous Medley-*Air* affords each *Animal*, and each *Plant*, ſuch Particles as are adaptable to its Nature, without, at the ſame time, communicating noxious *Particles* with which it muſt neceſſarily abound? How comes it to paſs, I ſay, that we are preſerved daily from the deadly and poiſonous Parts of *Matter* with which the AIR abounds, and never but on extraordinary Occaſions, when GOD *Almighty*, provoked by SIN, is pleaſed to chaſtiſe us, are infected by them?

How horribly ſhou'd we be diſguſted with the AIR received into our *Bodies* at every Reſpiration, if GOD had given us *Eyes*, piercing enough to diſcern all the *Particles* of Corruption, or a *Taſte* fine enough to diſtinguiſh the diſagreeable Savours of an infinite Number of *Particles*, exhaling from all kind of Filth and and Naſtineſs, ſucked into our *Bodies* by every *Diaſtole* of the Lungs?

There are ſome ignorant People who affirm *Winds* to be uſeleſs, or even troubleſome *Meteors*; and yet 'tis a manifeſt Truth, that without *Wind* we ſhou'd not be able to live upon the *Earth*; the *Air* wou'd preſently become infected by our Breath, by Smoak, by Vapours and Exhalations from the *Earth*; and we cou'd be no more able to endure it, than a *Fiſh* can bear living in ſtill, muddy, or ſalt *Water*, which was uſed to enjoy freſh, clear, and running *Streams*. Moreover, if there were no *Winds*, the Vapours, which riſe in great Abundance from the SEA, wou'd fall again into the ſame place from whence they were attracted; ſo that the *Land* being ſcorched, wou'd become barren, and *Rivers* and *Fountains* dried up. We do not at preſent ſpeak of other Advantages which the Induſtry of Man has been able to reap (by the Means of *Winds*) from *Navigation*, nor the Benefit we receive from *Wind-Mills*, placed in ſuch Parts, where the Conveniency

of Water-Currents are not to be had. 'Tis a vulgar Opinion, that *Winds* blow without any Method or Rule: But altho' the *Natural Hiſtory* of Winds is hitherto very imperfect; yet enough is known of that Subject, to convince us that *Winds* are guided by ſuch certain Rules as cou'd not be eſtabliſhed by any thing leſs than a *Being* perfectly wiſe, and *One* that loves *Mankind*. Without theſe regulated *Winds* a good Part of the *Earth* had been ſtill unknown to us; and we ſhou'd be deprived of all the Commodities we receive from the INDIES, both *Eaſt* and *Weſt*; for to the *laſt* there cou'd be no Paſſage by *Land*; and as for the *other*, there cou'd be no getting to it, but with a great deal of Trouble and Hazard, which muſt render a Journey by *Land* to the *Eaſt-Indies*, next to an impoſſible Task.

3. WATER makes the Subject of the Twentieth *Contemplation*; without this *Element* all *Animals* and *Vegetables* muſt periſh with *Thirſt*; nay, they wou'd even be deprived of *Suſtenance*; for it is moſt evident, that *Water* is the conſtituent Matter of *Plants*, by which *Animals* are nouriſhed. *Metals* and *Minerals* themſelves cou'd not be formed in the EARTH, without the Aſſiſtance of *Water*. Our *Author*, and ſeveral great *Philoſophers*, confirm the Opinion of thoſe who believe that *Water* changes it ſelf into *Earth*: And whether this be effected by the proper Parts which were Water becoming *Earth*; or whether *Water*, being a mixed Body, ſuffers a great Quantity of *Earth* to inſinuate it ſelf into the Compoſition of it, ſeems the Matter in Diſpute.

To the End that this *Element* may be uſeful to all *Animals*, *Vegetables* and *Minerals*, 'tis neceſſary for it to be rais'd up in *Vapours*, and afterwards to fall down in *Rain*, to water all the Parts of the *Earth* which ſtand in need of it. *Philoſophers* are at a Loſs

a Loſs to know how it happens, that the Parts of *Water*, which are ſpecifically heavier than the Parts of *Air* of equal Magnitude, do nevertheleſs aſcend and keep themſelves ſuſpended in *Air* a conſiderable time. To ſolve this *Phænomenon*, Dr. *Nieuwentyt* ſuppoſes, that the Parts of *Fire* have an Exiſtence, and ſomething in their own Nature diſtinct from the Parts of other *Matter*, contrary to the *Carteſians*, who wou'd make *Fire* conſiſt in the rapid Motion of minute Parts of *Matter*, inſomuch that *Matter* becomes *Fire* as ſoon as it is divided into *ſuch* minute Parts; theſe Parts, at the ſame time, acquiring a certain Degree of Motion. Our *Author* ſuppoſes further, that each of theſe Particles which he wou'd have eſſentially the Parts of *Fire*, and not of *Matter* put into ſuch a Degree of *Motion*, altho' it has a Gravity, yet is nevertheleſs ſpecifically lighter than a Particle of AIR of equal Magnitude. Laſtly, he ſuppoſes that theſe Parts of *Fire*, uniting with the Parts of *Water*, do, by Conſequence, cauſe the *Water* to become of a leſs ſpecifick Gravity than *Air*, and therefore to mount and float upon it; the ſame way that a little bit of *Iron*, tied to a piece of *Cork*, wou'd be capable of ſwiming on *Water*. To conclude all, he explains how theſe little Parts of *Water*, unlooſing themſelves from the Particles of *Fire*, may again reunite in the *Air*, and become of greater ſpecifick Gravity than *Air*, and conſequently be reſolved into *Rain*.

All this demonſtrates the Wiſdom of the CREATOR, and his Goodneſs towards his *Creatures*: Theſe Perfections appear yet greater in this, *viz.* that theſe *Vapours* furniſh *Rain*, ſweet and freſh, altho' the *Sea*, from which they riſe be ſalt, and unpleaſant to the Taſte; and it ought to be exactly thus, to render the *Earth* fruitful, which becomes barren when it is moiſtened with *ſalt Water*. Who does not ſee, in all this, the *Effects* of a moſt wiſe

Pro-

Providence! We find in this *Contemplation* the great uſe of *Mountains*, as well to collect the Vapours, and convert them into *Rain*, as to become the Origin of *Fountains* and *Rivers*; the Uſe of which every one experiences daily.

The *Sea*, which furniſhes *Fountains* and *Rivers* with freſh Water, yet ought it ſelf nevertheleſs to be *ſalt*; otherwiſe theſe *Waters* wou'd ſoon become corrupt, and uſeleſs to ſuch a Number of *Fiſhes* as are there ſuſtained alive; the *Air* would be infected with its Stench, and the Earth rendred uninhabitable for *Men* and *Beaſts*. What is yet well worth obſerving is, — that *Fiſhes* deſtined to live in *Water*, and there ſeek their *Food*, have *Eyes* formed exactly as they ſhould be, to ſee diſtinctly the *Objects* therein; as the Creatures alſo, which live on the *Earth*, have their Eyes formed for diſtinctly ſeeing *Objects* in the *Air*; a Thing which could hardly be the *Effect* of *Chance*.

If we were to omit nothing worthy of the Attention of the *Reader*, we ſhou'd copy entirely all that the *Author* has ſaid in this whole Contemplation.

He treats of the *Earth* in the 21ſt *Contemplation*; and here he takes pains to prove, beſides other Matters, how the *Earth* affords Nouriſhment to *Plants* and *Animals*: And notwithſtanding the Expences it is daily at, its Subſtance being continually diminiſhing, yet the Wiſdom of GOD has taken care to repair, by ſome Means or other, all the Loſſes it ſuffers by theſe conſtant Conſumptions.

He proves the Raſhneſs of thoſe Perſons, who dare advance, that *Mountains*, *Deſarts*, *Rocks*, &c. are uſeleſs, becauſe we are not made ſenſible of the Benefit of 'em: And he makes uſe, on this Occaſion, of the Inſtance of the *Load-Stone*, the principal Property of which was utterly unknown during ſo many *Ages*; but being now diſcovered, has furniſh'd

us with Means to find out a New *World*, from which great *Treaſure* is tranſported: For now *Mariners* dare venture to ſail on the main *Ocean*, and truſt themſelves out of the Sight of *Shore*; Attempts which the *Ancients* cou'd never believe to be feaſible.

'Tis an *Effect* of the moſt wiſe *Providence*, that the *Waters*, which are lighter than the *Earth*, do not entirely overflow and cover the Land, thereby rendering it quite uninhabitable! 'Tis a GOD, indiſputably, who has confined *them* within their proper *Bounds*, and has made them keep within their own Precincts for ſo many Ages paſt, without diminiſhing, in any conſiderable Proportion, the *Banks* which have all this while hemmed them in! 'Tis a GOD certainly who preſerves the *Earth* in the exact Situation it enjoys! inſomuch, that tho' it *floats*, as it were in a liquid *Ocean* of *Air*, yet its *Poles* are always in the ſame Poſition; altho' it ſeems, to humane Reaſon, a very poſſible Matter for it to have its Situation altered, and its *Poles* placed in another manner, ſo as to conſtitute two *Points* directly oppoſite to the *Equator*; and the two *Points*, which are at preſent oppoſite to the *Equator*, might become the *Poles*. If this ſhou'd happen, as to humane Reaſon, 'tis a moſt probable thing, the *Earth* muſt wholly become barren and fruitleſs; becauſe all the *Plants*, and all the *Animals* which it produces, wou'd find themſelves in a ſtrange and different *Climate* to what they had been nurſed and brought up in: Therefore theſe ſort of *Plants* and *Animals* cou'd neither be produced, nor live when produced, in *Temperatures* quite oppoſite to their *Natures*.

FIRE is the Subject of the 22d *Contemplation*: Every one knows the Advantage and Uſe of *Fire*; but no one, as yet, has found out the Nature of *Fire*, at leaſt ſo well as to be able to give a ſatisfactory Account of it. Our *Author* deduces a great many

Ex-

Experiments, which ſeem to prove what we have been above obſerving of his Notions of *Fire* being a particular kind of *Matter*, which hath, and which always retains a *Figure* and *Form* peculiar to it ſelf. This appears, (1.) becauſe all ſorts of *Matter* are not convertible in *Fire*: (2.) If to make *Fire*, it were ſufficient to give a certain *Motion* to the Particles of Matter; How comes it to paſs, that *Water* can never have its Parts put into ſuch a *Motion* as may conſtitute *Fire*? Our *Author* abounds with other *Reaſons* and *Experiments* proving the ſame thing.

As *Fire* is an *Element* ſo neceſſary that *Plants* and *Animals* cannot be without it; ſo its *Effects*, in other Caſes, are extremely terrible. If we conſidor the Quantity of Ignite Particles which are laid up as well in the *Earth* as in the *Air*; and the great Quantity of combuſtible Matter, which is to be met with in all Places, it muſt neceſſarily be acknowledged a particular *Providence* which has preſerved hitherto the *Earth*, and all things contained in it, from the raging *Effects* of ſo dreadful an *Element*: And theſe very Reflections ought to render the Predictions of St. * *Peter* probable to all *Infidels* and *Heathens*, viz. *That the Earth ſhall at laſt be conſumed by* FIRE.

On the Subject of *Fire*, Dr. *Nieuwentyt* asks the *Atheiſts*, whether it be by *Chance* that the SUN, an immenſe *Ocean* of the moſt active Fire imaginable, is placed at ſo great a Diſtance from the *Earth* as we find it is? It being near enough to afford ſufficient Heat for the Produce of ſuch various *Beings*, as owe their Life, as well as their Preſervation, to its influencing *Rays*: But if inſtead of the Diſtance it is now at, from our *Earth*, it ſhou'd approach nearer to us, it muſt inevitably follow, that all things

* 2 Epiſt. of *Peter*, Chap. iii. Verſes 7, 10, 12.

things we ſee now flouriſh, wou'd be conſumed and burnt up; and if it were to be removed farther from us, its *Rays* wou'd not bring ſufficient *Heat* to nouriſh the *Beings* which are now produced.

The *Author* proceeds, in the 23d *Contemplation*, to the Examination of Terreſtrial *Beaſts*, *Birds* and *Fiſhes*; from all which, we may very well conclude, he does not fail to enrich himſelf with Variety of *Matter* for proving his Purpoſe, *viz.* the *Exiſtence* of a GOD, and how much we ought to admire his wiſe *Providence*: But far from entering on the Particulars of each of theſe things, it is not ſo much as poſſible for me to hint at ſuch a Number of curious and profitable Remarks; I am therefore forced, unwillingly, to paſs over in ſilence the greateſt Part of them.

'Tis carrying *Infidelity* to the higheſt Pitch, to attribute to *Chance* the Formation of a ſingle *Fly*; he muſt be blind that cannot ſee the Hand of an infinitely wiſe and intelligent *Author* in the Formation of the Body of theſe *Inſects*; who hath, with ſuch marvelous Induſtry and Fore-ſight, produced the *Male* and the *Female* for the Preſervation of the *Species*; inſomuch, that the Doctor challenges the *Unbelievers*, who attribute all things to *Chance*, or a *fatal Neceſſity*, to muſter up all their *Art*, and joyn together all their *Subtilty*, towards the Formation of but one ſingle *Cheeſe-mite*; and if they cannot bring this to paſs, he adviſes them ingenuouſly to confeſs, that the *Wiſdom* which contrived this *Mite*, is infinitely above their weak *Power*, *Capacity* or *Reaſon*, in that, and every Particular.

This ſame *Wiſdom* of the CREATOR, appears in the Manner in which *Feathers*, or the *Wings* of *Birds*, are formedfor, raiſing them up into the *Air*, for ſupporting them there, and moving them about therein, according as all this is neceſſary to their Preſervation. Who does not admire the Care that

GOD

God has taken of ſeveral ſmall *Birds*, which are deſign'd to fly conſtantly into *Buſhes* or *Hedges*, amongſt Thorns, or to paſs through the *Branches* of *Trees!* For theſe Birds are provided with a tranſparent *Eye-lid*, whereby their *Eyes* are preſerved from the Sharpneſs of the *Thorns*, and yet they are not hindred from ſeeing neceſſary *Objects*.

What is remarked in this *Contemplation*, concerning *Fiſhes*, is a Proof no leſs evident of the *Being* of a *Providence*; for conſidering we obſerve in them a Capacity of rendering their *Bodies* of a greater or leſs ſpecifick Gravity than the *Water* in which they ſwim, by the Means of certain Veſſels, or Bladders, which are more or leſs fill'd with *Air*; to the End that they may be able either to ſink down to the Bottom, or riſe to the Top of the *Water*, or ſtay in the ſame Place, as they have Occaſion; and all performed according to the moſt exact *Laws* of Hydroſtaticks: There is nothing can be a greater Mark, than this, of the *Providence* of God.

The marvelous *Metamorphoſes* of *Silk-Worms* and *Flies*, and ſeveral other Sorts of *Inſects*; all which anſwer directly to the *End* for which they were formed, cannot be any thing leſs than the *Effects* of an *All-wiſe* Providence *, far ſurpaſſing all the fabulous *Metamorphoſes* of *OVID*, and other *Poets*.

The *Author* pitches on *Plants* for the Subject of his 24th *Contemplation*; from which I ſhall only draw this ſingle Remark. The generality of *Plants* ſow themſelves; or where any of them are ſown by *Husbandmen* or *Gardeners*, the Seed is thrown careleſly from them: Yet, notwithſtanding theſe *Chance-Caſts*, that every *Grain* ſhou'd have its proper

* Mr. *Goedart*'s curious Experiments on this Subject, are worth looking into: See his *Natural Hiſtory* of *Inſects*, printed in ſeveral Languages.

per Situation, eſpecially that thoſe *Seeds* which have almoſt a *Spherical* Form, ſhou'd always happen to be with the right Side uppermoſt within the *Earth* that covers them, is very ſtrange! Does all this come by Chance? Since every Body knows 'tis againſt the Nature of *Chance* to be uniform, or always the ſame way. Grains ſet different ways, whether they be turned wrong in covering them with *Earth*, or whether they be placed ſo in the Earth at firſt, change nevertheleſs their Situation: And notwithſtanding the wrong Poſture they may be placed in, yet each one ſends forth its *Bud* uniformly upwards, and its *Root* downwards. And it is remarkable, that theſe oppoſite Directions of the *Bud* and the *Root* are perpetually uniform; whether they germinate in the *Air*, or whether they germinate in the *Earth*. In this is plainly perceived the wonderful Care of Providence for the Preſervation of the *Species*, and the Fertility of *Plants*: All the Induſtry of Man cou'd never have been able to have procured this Advantage, if the *Wiſdom* of GOD did not interpoſe therein.

PART III.

THE 25th *Contemplation* is the longeſt in the whole Work, having for its Subject the immenſe Scope of the *Heavens*, and the principal Diſcoveries made *there*. The Author relates the various Methods made uſe of by *Aſtronomers* to find out the real *Magnitude* of the SUN; and he believes the certain *Bulk* of this Glorious *Star* is ſo far found out, that we may aſſure

our

our ſelves, without Fear of Deception, that it is proved to be a hundred thouſand times bigger than our *Earth*, and that it is at the Diſtance from us of ten thouſand *Semi-Diameters* of this *Earth*. [*'Tis computed, that if a* Cannon-Bullet *were ſhot from this* Earth, *and were always to proceed forward with its firſt Velocity, it ought to be twenty five Years in its ſwifteſt Motion before it cou'd arrive at the* Sun; *and the ſame* Cannon-Bullet *wou'd be about* 691,600 *Years in the ſame Motion before it cou'd reach thoſe fixed* Stars *which are placed the neareſt to our* Earth.] This *Magnitude*, and this *Diſtance*, are found abſolutely neceſſary for the Purpoſes to which this *luminous Body* is adapted: Nor are we leſs beholden to its *Diurnal* and *Annual* Motion, than to its *Diſtance* and *Magnitude*; for 'tis by theſe Means that a Difference is made betwixt the *Day* and the *Night*, as well as betwixt the ſeveral *Seaſons* of the *Year*: Without this Difference the *Earth* cou'd not bring forth its *Fruits*; nor cou'd it otherwiſe ſupport the Diverſity of *Plants* and *living Creatures* that we find upon it.

" * Perpetual *Spring*, which ſome have regarded " as one of the Advantages of the *Golden Age*, is a " mere Poetical *Chimera*; for this wou'd prove one " of the greateſt Misfortunes that cou'd happen to " the *Earth*."

Our *Author* ſpeaks much of *Light*: He repreſents the exquiſite *Fineneſs* or *Minuteneſs* of its conſtituent *Particles*. It is demonſtrated by the Learned of the preſent Age, that *Light* is communicated ſucceſſively from one Place to another; and it is computed to be about half a Quarter of an *Hour* in its Progreſſion from the Sun to us: But it is yet an unknown Queſtion, whether *Light* really paſſes from the Sun to us; or whether the Sun does not put into *Motion* ſome very ſubtile *Particles* of *Matter*, which

* An Addition of Mr. *Bernard's*.

which are continued (as it were in a Chain) from that Glorious Body even to this *Earth*?

Our *Author* sides with Sir *ISAAC NEWTON* in embracing the former Opinion: He speaks also of *Natural Laws*, which *Light* observe and moves by; as how it always proceeds in *Right Lines*; and how its *Rays* are refracted in passing oliquely from one *Medium* to another; in all which he endeavours to raise our Minds to an Admiration of the Wisdom of the CREATOR.

Nor is it a Matter less deserving our Wonder, that the SUN shou'd continue to furnish out from its *Body*, for so many *Ages*, Particles of *Light* in such great abundance, without having, all this while, sensibly wasted or distinguished its Substance.

" * For my Part, I must own, that I cannot yet " be throughly perswaded that that *Light*, which " strikes our *Eyes*, is an Emanation of subtile " Matter from the very *Body* of the SUN: I " can better square my Sentiments to theirs, " who believe the SUN acts only on a *Medium*, " which is betwixt *it* and the Extremities " of that *Space* wherein Light is manifested. " *ARISTOTLE* seems to me to have had " these Sentiments of *Light*: And *DESCARTES* " is something of the same Opinion, whose *Globula* elsewhere do not so well agree with Experience."

We cannot in the least, by *Hypotheses*, explain the following *Phenomenon*, which ought, without doubt, to pass for one of the *Miracles* of *Nature*. Place a *Convex Mirour* (or *Lens*) at the *Hole* of a Chamber; into which Chamber, no

* This is added by Mr. *Bernard*.

other *Light* but what paſſes thorow that *Hole* can be introduced; and you will receive from without the reflected *Rays* of ſeveral *Bodies*, *coloured* and *enlightned*: All theſe *Rays* being united, in the *Focus* of the *Lens*, loſe in ſome ſort at their Re-union, their proper *Colours*; all of them jointly forming only *White*. After this *Union* they are ſeparated again, and paint very diſtinctly on white Paper, all the External *Objects* coloured (each appearing in its proper and particular Colour) and this after ſo curious and exact a Manner, that there is no Painter on Earth, let him be ever ſo skilful, that can delineate thoſe Objects half ſo exact. If all this be the Effect of *Hazard*, it muſt be allowed, that *Hazard* is a very fine *Artiſt*. [§.] The ſame may be ſaid in relation to the Diſtance of the *Planets* in reſpect to the SUN, of their Elliptic Motion about the SUN, and a great Number of other *Phænomenas* of the *Heavens*, and the *Stars*, *&c.* which are the Wonder of *Wiſe Men*, and the *Objects* of their Enquiry.

Dr. *NIEUWENTYT*, in his 26th *Contemplation*, demonſtrates how inconceivable the Number and Minuteneſs of the Particles of all Bodies are; and he opens this Subject with moſt curious Calculations.

I ſhall make a ſingle Remark on this Occaſion: It is moſt certain, that we do not ſee the real Magnitude of *Bodies*, but only the painted *Image*, repreſenting the *Relation* that thoſe Bodies have to the *Form* or *Structure* of our *Eyes*. Let us ſuppoſe then a *Glaſs*, *Concave* on both Sides; each *Concave* Side being as perfect a Part of a *Sphere* as can be imagined; this Glaſs will repreſent to one Eye (becauſe it can't ſerve both at once) *Objects* ſeveral *Millions* of times leſs than they appear to us. Here then, ſuppoſe our

Eyes

Eyes to be made like this *Glaſs*, we ſhou'd not, eaſily, be able to conceive *Parts*, which, with the naked *Eye*, we diſcover in *Bodies*; becauſe thoſe *Parts*, in regard to us, would be of a Smallneſs almoſt ſurpaſſing our Imagination. Let us again repreſent to the Mind the moſt perfect *Microſcope*, that is poſſible for the Art of Man to contrive; with this *Microſcope* we may be able to ſee *Millions* of *Bodies*, which we can no wiſe perceive without ſuch Aſſiſtance: And if, finally, we ſuppoſe, that our *Eyes* were formed like this *Microſcope*, we ſhou'd ceaſe to wonder at the Minuteneſs of the Parts of *Bodies*, which now ſurprize us to perceive, or even think of. On the contrary, we ſhou'd admire that People who have ordinary *Eyes*, ſhou'd not apprehend *Bodies* to be formed in ſuch Manner as they wou'd appear to us with our *Microſcope Eyes*. All this tends to prove, that what our Learned *Author* advances on this Occaſion, has a real Foundation in Nature; and that, as he argues, there is nothing can make us comprehend better the *Being* of a God, who by his infinite *Wiſdom* hath compoſed all Bodies of ſuch a numberleſs Multitude of *Parts*, as can ſcarce be conceived by finite Underſtandings. This is more eſpecially true in Relation to the infinite Minuteneſs of the Parts of *Light*, and may help us to comprehend what has been ſaid juſt now concerning the *Sun's* not being diminiſhed, notwithſtanding the great Expence it is at daily in furniſhing out ſuch a prodigious Number of Particles of *Light*, as Sir *ISAAC NEWTON*, in his incomparable Syſtem, has enumerated: Here you meet with a long and curious Calculation, which helps to convey the Minuteneſs of the Particles of *Light* to the Apprehenſion. According to his Calculation it appears, that there

ſlows from a *Tallow-Candle*, in one *Second* of a *Minute*, 41866[12] * Particles of *Light*.

Certain *Laws* of *Nature* are the Subject of the 27th *Contemplation*: Such are the *Laws* by which *Bodies* are united to, or ſeparated from one another; as alſo the *Laws*, which all Bodies obſerve in tending towards the *Centre* of *Gravity*, and preſerving regularly a Continuation of Motion, or communicating Motion to other Bodies, *&c.* Theſe are *Laws* ſo neceſſary to the Conſtruction of the *Univerſe*; that, without this Order, the *Earth* muſt ſoon be deprived of all manner of *Inhabitants*, and the Univerſal *Orb* of *Nature* wou'd return to its former CHAOS. In this *Contemplation*, the *Laws* which *Fluids* obſerve in their Aſcenſion are inſerted.

On this, ſo curious and important *Subject*, a whole Treatiſe might eaſily be compiled. To conclude this *Contemplation*, our *Author* ſhews the Advantages, or rather the abſolute Neceſſity, of ſuch *Laws* as theſe.

In the 28th *Contemplation* he diſcourſes of thoſe *Laws* of *Nature*, which are properly termed *Chymical*, and which conſiſt, chiefly, in the various *Effects* produced by the different Mixtures of *Alcalies* and *Acids*. And here he excites our higheſt Admiration, in ſhewing, that tho' the Earth abounds with ſuch an infinite Number of different *Particles* mixed, and as it were confounded, or jumbled, together, ſome of which being of the moſt poiſonous Nature; yet it does not, for all this, allow *Corn*, or other wholſome *Plants*, to imbibe any of the poiſonous Parts of *Matter*: But on the contrary, theſe Vegetables, deſign'd for

* 39 marked thus, [12] denotes 39 Cyphers are to be added to the former five Figures thus; 41866000, *&c.*

for the Nouriſhment of *Man*, ſuck in, towards increaſing their Subſtance, ſuch Parts only as are wholſome, and fit for the Nouriſhment of his Body; leaving at the ſame time, in the *Earth*, all thoſe poiſonous Parts which wou'd hurt him.

The 29th *Contemplation* is perhaps one of the moſt curious throughout the whole Book: The *Author* here proves the Poſſibility of the *Reſurrection* of the ſame *Body*, ſuch as the *Scripture* promiſes, and anſwers all the Objections which are brought againſt this *Truth*. We ſhall neither repeat thoſe *Objections*, nor his *Anſwers* to them, contenting our ſelves to explain, in as few Words as poſſible, how Dr. *Nieuwentyt* conceives, that the ſame *Body* may be able to ariſe. The *Body* of *Man* may be conſider'd as two different *Bodies*, or the ſame *Body* may be apprehended under two different *Ideas*: The Firſt is termed, — *The Viſible Body*; the Second, — *The Proper Body of Man*. The Viſible Body changes every Day; by little and little it attains full Growth; ſometimes it is *fat* and *plump*, at other times it is *lean* and *emaciated*: 'Tis in this Senſe therefore, that the Body may be ſaid to be in perpetual Change, or Flux; and that a *Man* at Fifty or Sixty Years of Age, has ſcarce a Scrap of the ſame *Body* which he enjoyed at Ten or Twelve Years of Age. The *Proper Body* of a *Man* is, — that Body by which a Perſon is always diſtinguiſhed to be the ſame Perſon, and not another; and this not only with regard to his having the ſame Soul, but alſo as he may be ſaid to have the ſame *Body*, with ſome peculiar Properties diſtinguiſhing it from all other Bodies; there muſt be then ſomething in this *Proper Body* which is the Cauſe of its being denominated the ſame Body. It is therefore neceſſarily one of theſe three things, *viz.* either Firſt, the

Solid

Solid Parts of which it is compoſed; or, Secondly, the *Fluid Parts*; or, Thirdly, certain *Natural Laws*, which are obſervable in the *Oeconomy* and Functions of the Animal Body: It cannot be the Fluid Parts, becauſe, tho' the *Fluids* are daily diſſipated, and other Similar Parts conſtantly ſucceeding, yet we ſay, without Impropriety of Speech, ſuch a Man has the ſame *Body*; neither can it be the *Natural Laws*, becauſe theſe *Laws* alſo change, or are in a continual *Flux*, according as the *Body* is in *Health* or *Sickneſs*, *Fat* or *Lean*; but more particularly, becauſe theſe *Laws* ceaſe by the Death of the *Body*, when even the *dead Carcaſs* continues to be call'd the *Body* of him to whom it belonged. It muſt be concluded, therefore, that the *ſolid Parts* of *Man's Body*, are thoſe Parts which denominate the *Body*, and cauſe it to be eſteemed the *ſame*, or *proper Body* of any Perſon.

Moreover, 'tis taken for granted at preſent, that the Body of *Man*, as well as that of Beaſts, and Vegetables, is found in Miniature, within the *Seeds*, or firſt *Principles* of the *Individuals*. Theſe little *Embryo's*, if it be allowable to term them ſo, do only, in Sequel of Time, unfold themſelves; and increaſe, by the Conjunction of new *Particles* of *Matter*, which they imbibe and embrace continually. Now this Body may be conſidered either as it was in its firſt State, before it came out of the *Husk*, *Caſe*, or *Shell*; or, ſecondly, in the State it is in, when the Shell being broke (like the *Shell* of a *Nut* or *Husk* of a *Bean*) it receives to its Subſtance adventitious Particles of Matter to increaſe its Bulk. If the *Body* of *Man* be conſider'd in this firſt State, this *Body* ſubſiſts always perfectly the ſame (as a *Nut* whilſt it remains out of the Earth); and it is preciſely the ſame Body

that

that a *Man* has poſſeſs'd ever ſince his Conception, which ſhall riſe again.

In this we can ſee no Contradiction; nothing that is impoſſible to the infinite Power of GOD: For GOD may add to this *Eſſential Body* of *Man*, either ſome Parts which the *Man* enjoyed at the *Moment* of his Death, or ſome of thoſe which he had before; or ſuch other Matter as he pleaſes: This does not in the leaſt alter the Identity of the ſame Body.

If we conſider theſe Bodies diveſted of the new Particles of Matter, that have been joined to the former Principles, we find ſome of them ſo emaciated and extenuated, that there remains ſcarce any thing but *Skin* and *Bones*; yet we do not ſcruple to ſay, that *they* are the *ſame Bodies* which will riſe again: So that it ſeems, as if the Identity of Bodies, in this Caſe, conſiſted in Nothing but the *Bones* of which they are compoſed. It is therefore ſufficient to enable us to ſay, *That they are the ſame Bodies which will Riſe*; when we are aſcertain'd, that ſomething remaining in *them* ſhall ariſe, tho', perhaps, with other *Additions*, which God may be pleaſed to make, either of borrowed Matter, or of ſome Parts of Matter which have properly appertained to theſe Bodies.

An intelligent *Reader* may plainly ſee, that by this manner of explaining the *Reſurrection*, all the Difficulties that are raiſed againſt this *Doctrine* (without dwelling any longer on this *Subject*) vaniſh.

The 30th *Contemplation* ſpeaks of divers Things in *Nature*, of which we have yet ſcarce any Knowledge. The *Author* ſhews, that from theſe very Things, which are unknown to us, we may draw *Arguments* in favour of the *Wiſdom* of GOD. He places the *Motion* of the SUN, or of the

EARTH,

EARTH, amongſt thoſe Things that are not yet ſufficiently known to us. He brings Reaſons and Authorities to prove, that we cannot yet certainly determine any thing of that Matter: And he believes, that this is the Queſtion which GOD put to JOB — * *Knoweſt thou the Ordinances of Heaven? Canſt thou ſet the Dominion thereof in the Earth?* Our learned *Author* fancies, that this Speech is thus to be conſtrued — *Knoweſt thou whether* it be the Earth, or the Sun which moves, or which of the two ſtands ſtill, or ought to be placed in the Number of the *Planets* which move themſelves in an Orb?

I ought not to forget, before I put a Period to this Matter, that the *Illuſtrious* and *Learned* MAGISTRATE, who is the Author of this *Book*, of which I have juſt now given a Sketch, has been pleaſed to do me ſo much *Honour* as to anſwer ſome ſmall Difficulties, which I had ſtarted againſt his Opinion (*in the* Nouvelles *of* March *and* April, *Pag.* 153.) 'Tis in a Letter inſcrib'd to me, and inſerted in the Month of *June* in the *Dutch Journal*, the Title of which is *Boekzael*, &c. *Pag.* 673, *&c.*

I cannot ſufficiently expreſs how much I am obliged to him, by the courteous Manner in which he treats me: I freely own that I do not deſerve the Compliments he paſſes on me. As for the Main of the Queſtion, ſince we each of us aim at the ſame *Point*, I wiſh, with all my Heart, that the *World* may judge my *Objections* ill-grounded; and that his *Anſwers* may prove moſt evident and convincing.

---

* *Job, ch.* 28. *v.* 23.

THE AUTHOR's Epiſtle TO THE READER.

THE Deſign of Writing theſe *Contemplations*, is to convince *Atheiſts* of the Wiſdom, Power and Goodneſs of God, the Maker and Ruler of all Things; and *Infidels* (who indeed acknowledge a God, but reject the Authority of the Holy Writings) that the Scriptures are of a more than Humane Original; and ſo to repreſent to both of 'em *the right Uſe of the Contemplation of the World.*

The Methods we have made uſe of to prove the ſame, are only taken from the *modern Obſervations*, and *probable Diſcoveries* in *Natural Philoſophy*, without laying down any bare Hypotheſes, ſince in the Things of natural Knowledge, we have no farther Foundation for Arguments than we can produce Experiments: Upon which, you may conſult the Writings and Plans of the *Royal Academies* and *Societies*, and of the moſt famous *Mathematicians* among them.

The Reaſon why I have not made uſe of the *Metaphyſicks*, &c. will appear in the *Preface*, Sect. 27.

While I was writing this, the *Arch-Biſhop of Cambray*'s Book fell into my Hands; and while I was compoſing the Preface, I met likewiſe with Mr. *Ray*'s Book, tranſlated into *French*; and was

moreover inform'd (tho' I don't underſtand the Language) that Mr. *Derham* had publiſhed another Book in *Engliſh*, wherein he largely proves the Being of a God upon the ſame Foundation. It was very agreeable to me, to ſee and obſerve, that this Way of Proof, which I have always eſteemed the ſtrongeſt, was likewiſe embraced by ſuch Great Men; in which, after all that is writ upon it, there ſtill remains abundance of Matter, to convince the unfortunate Philoſophers of the Perfections of their great Creator; and there will ſtill remain enough to lateſt Poſterity.

The Manner of *proving the Divinity of the Holy Scripture from natural Phenomena or Appearances*, which we here ſet before you, has not, that I know, been ever done before in ſuch a Method. I hope, however, that the ſame may be of Uſe both to the *Atheiſt* and *Infidel*, becauſe both thoſe are wont chiefly to exerciſe themſelves in the Study and Knowledge of Nature.

The general Method of convincing both of 'em, is more largely repreſented in the following *Preface*; *Sect.* 29, 30 and 31.

I write in the *Low-Dutch* Tongue, to the End that I may be more uſeful to my own Country-Men; and eſpecially, becauſe that Tongue has been often abuſed in Publiſhing and Diſperſing *Atheiſtical* Books.

The Order we follow, can in ſome Manner be learned from the Heads or Contents of this Work; tho' I have not confined my ſelf very ſtrictly to that which has been purſued by many others upon the ſame Subject.

Thoſe who will read this Work as an *Experimental Account of the Knowledge of Nature*, muſt not be offended at what we call the *Concluſions*, which they frequently meet with, becauſe our Deſign was not to write a Body of *Phyſicks* only, but

but to bring the Erroneous into the right Way; and by turning their Thoughts, after this manner, to the Knowledge of Nature, to lead them on to the true Notions of the Deity.

The able Mathematicians may perhaps think, that I ought to have propoſed the Experimental Demonſtrations for Inſtance, *of the Power of the Muſcles, and* of the *Hydroſtatical Laws in Fluids, &c.* in a more Mathematical Manner, or elſe barely to have related them without any farther Proofs, and ſo to have made the ſame Concluſions, without ſo much Trouble, and ſo many Figures; but they muſt be pleaſed to know, that I have deduced thoſe Demonſtrations as far as it was poſſible for me, by *Experiments* only, and not as the *Mathematicians* are uſed to do from *Eſtabliſh'd Laws* of *Nature*, to the End that I might be the better underſtood by ſuch as know little or nothing of the *Mathematicks*. I was indeed at firſt of a different Opinion, and had already prepared the whole Work without any Figures, and without Proofs, the Grounds of which were nevertheleſs very obvious to *Mathematicians*. But foraſmuch as a certain Learned Gentleman, and after him ſeveral others objected, that if I did proceed in ſuch a Method, many would think, that what I ſhould advance in ſome Caſes, was more incredible than true; and that in ſuch great Matters one ought to bring at leaſt as much Proof as would be neceſſary to confirm the Truth of one's Poſitions; I have therefore choſen to go on in that Way: This has likewiſe been the Reaſon why this Work, which I was forced to enlarge and alter in every Part almoſt, has ſeen the Light ſeveral Years later than it ought to have done, eſpecially ſince my other Affairs have continually obſtructed the ſame.

They who upon good Grounds do acknowledge a God, and the Divine Origin of the Holy Scri-

ptures, will here find ſufficient Proofs of their Confeſſion; and thoſe who are weaker, may likewiſe, I hope, be confirmed in thoſe Truths againſt any Temptations.

But before I conclude this Addreſs to my Reader, I muſt entreat thoſe *unhappy Philoſophers*, thoſe *wavering and doubtful Perſons*, *thoſe Infidels*, and much to be lamented *ſtrong Minds*, for whom this Work is chiefly calculated, that they would come prepared to conſider the ſame, not ſo much with an accute, as with a ſerious Judgment, and decent Reſpect for ſo momentous an Enquiry; and not ſo much to obſerve what Difficulties may occur in ſome Particulars, as whether there is not ſomething in ſuch a Number of Things as may ſerve to convince them of the Perfections of their Maker, and of the Authority of his Word. If they proceed in the firſt Way, the ſtrongeſt Proofs will be of no Uſe to them; but if they fall into the latter, one ſingle Fact weighed by a Mind in earneſt, and diſpoſed to learn, may, by God's Bleſſing, convince them of their Errors.

The *Thetical* Way, which is only made uſe of here for their Conviction, muſt not appear imperfect to them, as if it did not ſufficiently confute their Sentiments, but let them compare it with their own Poſitions, and judge themſelves, whether a Proof deduced from certain and actual Experiments, which is the Caſe here, ought not to be more convincing, than that which is grounded upon naked Ideas; which, wit out any actual Experience to ſupport them, are h rbitrarily advanced for Notions of things really exiſting, and that their Philoſophy is only built upon this latter Foundation, they themſelves muſt know. Accordingly, the Sophiſtical Arguments of thoſe Atheiſts, and the not only falſe, but horrible Conſequences flowing from their Opinions, hav: been already

fully expoſed by divers eminent Perſons, to whoſe Writings we refer you.

If there ſhould be any thing among all theſe Contemplations, in which, according to the Opinion of the Reader, I may have been miſtaken, and have not rightly repreſented the Properties of the Natural *Phænomena*, let him paſs it over, ſince he will not be able to ſay the ſame of all the reſt; and in caſe he allow one ſingle Proof to be ſtrong enough among ſo many as are here brought together, or of thoſe whereof the farther *Contemplation of the World* may yet ſuggeſt a much greater Number to him, that alone will be powerful enough to convince any Man that argues rationally of the Being of a God, and of the great Origin of his Word, ſince one Demonſtration proves as ſtrongly as ſeveral, tho' more do ſtrengthen the Conviction.

Neither let the Quotations of Scripture-Texts, in theſe Diſcourſes, make you reject the whole Work without reading it, as many are uſed to do when they meet with them in any Books, ſince the Divinity thereof is not here ſuppoſed but proved; and that ſome of them ſerve to ſhew the Wiſdom and deep Knowledge in Nature of him that inſpired them; and others, to convince you that no Man, tho' never ſo underſtanding, nor any Impoſtor tho' ever ſo cunning, either for Political Reaſons, or otherwiſe, was capable to produce in thoſe Times ſuch things as we find written therein, from whence you may eaſily conclude who has been the Author of them.

Let not the Atheiſts and Unbelievers conceive a Prejudice againſt this Work, ſince they may learn not only from the Title, but from thoſe ſincere Aſſurances we hereby give them, that we did not write it out of the leaſt Hate or Contempt of them, but from a hearty Sorrow for their

miſerable Condition, and only in order to their Converſion; for which Reaſon, I have commonly made them themſelves the Judges of the moſt part of my Concluſions; I therefore only intreat them, that they would paſs their Judgment upon what is here ſubmitted to it, without that deplorable Reſolution taken up by many of thoſe who call themſelves *Strong-Minds*, or *Free-Thinkers*, not to acknowledge the Being of a God.

One of theſe Poſitions muſt be irrefragably true (it being impoſſible to lay down a Third) either that, according to their Opinion, all Things in the World are govern'd by *Chance*, and by *neceſſary Laws*, without the Intervention of an Intelligent Being, and that the *Chriſtian Bible* is compoſed by *Cheats* and *Impoſtors*, who had no other View but their own Advantage; or elſe, that the *Holy Scriptures* are given by a *God* that *Governs* the *World*, and who will require an Account from thoſe Creatures whom he has endued with Reaſon, how they have uſed the ſame. *Let them therefore conſider how much it imports them not to be miſtaken in thoſe things, whereon their eternal Welfare or Miſery depends; and let them judge whether it be not at leaſt as true, that they and the World are made by a wiſe God, as that a Clock, or any other ingenious Piece of Workmanſhip, does prove the Skill of the Maker.* Upon all which, if they ſeriouſly contemplate, they will tremble at their own Notions; and ſince it is a Matter of Fact, and not a meer Speculation that is in queſtion, and ought to be examined, whether it be not neceſſary to enquire into the Things themſelves, without relying upon naked and Atheiſtical Notions; 'tis for this End theſe *Contemplations* are written. May the Almighty *God*, who alone can over-rule our Minds and Thoughts, enforce theſe and other Proofs, in which the whole World abounds!

THE

THE PREFACE, OR INTRODUCTION, TO THE Following *Contemplations* of the WORLD.

SECTION I. *The true Difference between Atheists, and those that fear GOD.*

IT is hardly credible, that there were ever any Men, who had not quite loſt their Underſtanding, ſo fooliſh and unreaſonable as to deny an *Eternal* and *Self-exiſtent Being*, and to maintain that there has been a perfect State of *Inanity* or *Nothingneſs*, in which there were neither *Creator* nor *Creatures*; for even the moſt Famous among the Ancients, and *Spinoſa* himſelf among the Moderns, tho' they may juſtly be rank'd with the *Atheiſts*, have yet acknowledged an *Eternal Being*.

The great Difference therefore between *Atheiſts*, and thoſe who confeſs and fear a *God*, is not whether there be ſuch a Being, which from all Eternity has ſubſiſted by himſelf (for that is owned by them all, at leaſt by all that I have ever heard of) but whether this Eternal Being is alſo *Wiſe*, *Powerful*, and *Merciful*; and whether he has made all things according to his own Pleaſure, for certain Ends and Purpoſes, and does continually direct and govern the ſame.

It is true indeed, that thoſe miſerable Wretches find themſelves obliged, in ſome Manner, to confeſs his *Power*, were it only from their daily Obſerving, with their own Eyes, what great Bodies are moved in the Heavens with an unſpeakable Swiftneſs; and perhaps alſo, they might own his *Goodneſs* and *Mercy*, if we allow them to explain it in their own Senſe, and to aſcribe the Goodneſs of this Being only to the happy Qualities of Things, making uſe therein of their own Underſtanding, by which they think they are able to convert moſt Things that occur to them in the World to their own Advantage, and to render them ſubſervient to their own Neceſſities and Pleaſures: But with great Difficulty will they allow, upon their Principles, that this Eternal Being is *Wiſe*, and orders all Things according to his own good Pleaſure; becauſe ſuch a Conceſſion would be entirely inconſiſtent and contradictory, as well to *a meer Chance*, as to all the *unknown Laws of Nature or Neceſſity*: This is alſo the only Foundation of their continual Uneaſineſs and Terror; ſince if this Being is *Wiſe*, and knows that they endeavour blaſphemouſly to rob him of his Attributes and Perfections, they may eaſily conclude what will be their Reward hereafter.

That

That this was likewiſe the old Queſtion in former Ages, may be inferr'd from the Writings of *Cicero* about it; where the Diſputations of the Philoſophers, by him introduc'd, do not ſo much turn upon the *Exiſtence* of a *God* (meaning thereby ſuch an Eternal Being) as concerning *the Nature of the Gods.* It may therefore ſeem ſtrange, perhaps, to thoſe who from their Youth upwards have been ſo happy as always to acknowledge and reverence God, for their Almighty Lord, Maker, and Supporter, out of a Conviction of his adorable Perfections, to hear that there can be found a Set of Men, who owning an Eternal Being, or the Exiſtence of a God, do nevertheleſs conſider him as deprived or diveſted of the above-mention'd Attributes: And yet that both the former and latter Times have ſwarmed with ſuch deplorable Genius's, is too well known to fill this Book with the Relations of them. We ſhall therefore ſatisfy our ſelves with acquainting the Reader, that the following *Contemplations* are expreſly calculated to bring theſe unfortunate Men, if it be poſſible, to better Thoughts.

SECT. II. *In order to bring Atheiſts to Reaſon, it is neceſſary to inquire into the Cauſes and Remedies of Atheiſm.*

THAT we may therefore take the true Methods to arrive at this great End, it ſeems neceſſary in the firſt Place, ſeriouſly to enquire what are the real Cauſes that many fall into ſuch deplorable and irregular Opinions concerning this Tremendous and Eternal Being; and when we have come at the Knowledge thereof, to find proper Remedies to prevent the ſame.

But the Reader is deſired to take Notice, that we do not intend to treat of this Matter in its utmoſt

utmoſt Extent; we ſhall ſatisfy our ſelves only to collect ſuch of the Cauſes of Modern *Atheiſm*, which we have experimentally obſerved to prevail over the Minds of theſe ungodly Diſputers, and from thence ſuggeſt ſuch Means, as the ſame Experience has taught us to apply with good Succeſs againſt this lamented Evil.

SECT. III. *The Firſt Cauſe is* Inordinate Self-Love.

THE firſt Cauſe therefore, and which moſtly prevails in the Nature of Men, is uſually the *Paſſion of a too extenſive and inordinate Self-Love.*

From hence only it is, that Men deſire to gratify their Inclinations, and to be in Subjection to no body; and if they cannot be exempted altogether from the latter, they wou'd have it be no other kind of Subjection, than what is agreeable to their Carnal Appetites. Wherefore, hearing that there is a God, and that he is Juſt and Holy, and will be obey'd by them in all Things, and will certainly puniſh thoſe his Creatures that refuſe to acknowledge his Power, they earneſtly wiſh to be entirely freed from it.

This induces them to turn a deaf Ear towards all the Convictions of ſuch a Being; and foraſmuch as their Conſciences, in ſpight of all their Endeavours, will not ſuffer them to be eaſy, they are continually ſeeking out for Arguments, whereby they may perſwade themſelves of the contrary; and ſo ſtifle the dreadful Remorſes of ſuch their reſiſting Conſciences. For theſe Reaſons did the blind Heathens aſcribe to their Gods, *Paſſions* and *Inclinations* like thoſe which they felt in themſelves; pretending, that thoſe Gods delighted in *Drunkenneſs*, *Fornication*, *Adultery*, and other irregular Affections.

To

To look for no farther Proof of what has been advanced, let every Man who has been ſo unhappy as to hunt for Arguments to darken and blot out of his Mind the Knowledge of the Perfections of his Creator, retire into himſelf, and examine, whether if that, which is received by Chriſtians for the Word of God, and in which his Will is contained, ſhould allow him to abandon himſelf to all his Inclinations in this Life, and ſhould promiſe him the Enjoyment of the like Pleaſures through all Eternity, he would not endeavour with as much Zeal and Diligence to find out Reaſons whereby to convince himſelf, and every Man beſides, that there is a *God*, and that the *Bible* is his revealed Word, as he now Attempts to make himſelf, and others believe that the ſame is falſe. There is, however, an innate Deſire in every Man to become happy: Does he expect to find this in the Knowledge of a God? then will he extend his Deſires that way: But perceiving, that by the Acknowledgment of a Supreme Holy Being, he would conſequently be obliged to renounce his Sinful Pleaſures, he will wiſh that there was no ſuch thing as ſuch a God; tho' he dares not own the ſame, leaſt he ſhould be found out by others for what he really is, a miſerable *Atheiſt*.

I appeal for the Truth of what I have here ſaid, to thoſe Men who have ever lived in theſe ſad Doubts and Uncertainties, and in the mean time followed their Paſſions as far as they could, without incurring the Puniſhment of the Temporal Magiſtrate, and without Prejudice of their good Name or Eſtate, but have at laſt attained to a better Mind. It is not neceſſary to produce Examples of thoſe, who after their Converſion have openly avow'd the ſame, tho' I could eaſily do it.

SECT.

Sect. IV. *The Means to prevent this inordinate Self-Love.*

Now ſince this whole Miſtake is nothing elſe but a Paſſion that hurries them away without the leaſt Foundation or Shadow of Reaſon, many of this kind of *Atheiſts* are reduced to the right Way, when God (who in all theſe Caſes muſt be acknowledged to be the firſt Cauſe) ſhall pleaſe to ſanctify the Means that are uſed thereto; which, beſides the increaſe of Years, that often calms the impetuous Paſſions of Youth, do likewiſe ſometimes conſiſt herein, to wit, that they be brought to a right and ſerious Conſideration of the *Wiſdom*, *Power*, and *Goodneſs* of *God*, which undeniably manifeſt themſelves in the *Contemplation* of the *World*, and the Government of all Things in a multifarious Manner, to ſuch as are not reſolved to remain wilfully Blind; eſpecially, if the corrupt State of themſelves, and of all Mankind, and the Vanity of thoſe Things upon which they beſtow the Name of Pleaſure, be ſet before them in a proper Light; and eſpecially that unhappy Condition in which all Men would find themſelves, if, according to their own Opinion, the World were govern'd either by meer Chance, or by the Laws of blind Fatality. Finally, how dreadful would it be for them in caſe their deplorable Notions (for I cannot beſtow a better Term upon them, ſince no body can prove them) ſhould be entirely falſe. By which Conſiderations, a lower Value for preſent, and a greater Concern for future Things, would be produced in their Minds; which being oppoſed to their former Paſſions, might contribute to extinguiſh the ſame, and awaken in them ſuch ſerious Thoughts, as ſometimes are alone ſufficient to make them change their Opinions.

SECT. V. *The Second Cauſe is Inordinate Ambition.*

THE ſecond Cauſe of *Atheiſm* is another Paſſion, conſiſting in an *irregular Ambition, which ariſes from the ſame Source of Self-love, by which ſome, having once abandoned themſelves to the Defence of ſuch unfortunate Sentiments, fancy that they ought therefore to paſs with other Men for Perſons wiſer, and of greater Underſtandings*; and ſo they beſtow upon each other the Appellation of *Eſprits Forts*, that is to ſay *Strong-Minds*, or *Free-Thinkers*, being, as it were, deſirous to ſhew thereby, that they are ſuch ſtout and couragious Men, as are not to be terrified with vain Fears or Bugbears (as they term it) like the Vulgar and Childiſh People.

This is one of the higheſt Steps to which *Atheiſm* can attain, and indeed it cannot well climb higher; becauſe, when it is once arrived to that paſs, it does not only ſlight all Convictions, but ſo long as this Paſſion and inordinate Ambition continues, compels Men neceſſarily to reject them, and conſequently to remain altogether incurable. For whereas the firſt ſort of *Atheiſm*, which is only founded upon the Enjoyment of Pleaſures, may be ſilently oppoſed and conquer'd as ſoon as any contrary Argument begin to make an Impreſſion, this laſt has moreover this Obſtacle and Hinderance in the removing it, that thoſe who have once maintain'd it, altho' they ſhould change their Mind, are afraid of loſing their imaginary Eſteem, and the Honour of a Superior Wiſdom and Knowledge, and of being hence-forwards accounted by thoſe that know them, not only Cowardly and Unconſtant, but likewiſe Men of miſtaken Judgments: It being commonly the way of theſe conceited Strong-Minds,

minds, or Free-Thinkers, to ſpeak contemptuouſly of all that ſee their own Errors, and have Virtue enough to forſake them. Now how powerful the Fear of Contempt is over ſome Men who have a great Conceit of themſelves, we are taught by daily Experience in many Caſes; inſomuch, that this unhappy ſort of Creatures have been often obſerved to break forth into dreadful Blaſphemies, only to give a Proof of their greater Knowledge and Penetration, and to avoid the Suſpicion of ſpeaking againſt their Conſciences, and of diſſembling their juſt Fears.

SECT. VI. *The Remedy againſt this Evil.*

I HAVE ſeldom ſeen any Humane Means made uſe of with Effect againſt thoſe who will not be convinced; ſince this kind of *Atheiſm* is attended; for the moſt part, with great Ignorance; and that thoſe miſerable Wretches who are tainted with it, can be ſeldom brought to liſten carefully to the Arguments objected againſt them; being accuſtomed to anſwer the beſt and ſtrongeſt Proofs with Contempt and a ſcornful Smile, not judging them worthy of a better Return from their ſuperior Underſtandings. Yea, whatever may be the Occaſion of ſuch an exceſſive hardneſs and ſtifneſs of Heart, it is viſible that they lie under a dreadful Judgment of that GOD, whom they have ſo unrighteouſly blaſphemed, and ſo far as one may gueſs from Circumſtances, do often continue ſo to the End, unleſs the ſame merciful GOD be pleaſed to take Pity on them, and make them unconceivable Miracles of his Grace.

Among ſuch, I knew one, who having been adviſed by a Friend (for he was deaf to all other kind of Proofs) ſeriouſly to conſider himſelf,

ſelf, his Soul, and Body, and all that happen'd in the World round about him, began to perceive, that it was hardly to be believed, that he himſelf, and all beſides him, could be made and govern'd by any thing but a Being endowed with great Wiſdom: So that a little while before he died, he heartily thanked his Friend for the Counſel he had given him, and deteſting his former wicked Thoughts with a Flood of Tears, he continued to his Death to beg Forgiveneſs of that GOD, whom all his Life-time he had refuſed to acknowledge, praiſing, with his laſt Breath, the unexpreſſible great Mercy of his Divine Majeſty, who had vouchſafed to look upon ſuch an abominable Creature, that had deſerved nothing but his Wrath and Vengeance, with the Eyes of Mercy. I have known others of this kind, ſome of whom have in a harden'd Manner drowned themſelves; others, that have taken Poiſon, and the reſt ended their Lives in the utmoſt Deſpair upon their Sick-Beds.

SECT. VII. *Concerning the Death of* Spinoſa.

UPON this Occaſion of mentioning the miſerable Deaths of ſeveral Atheiſts, I cannot forbear to take Notice of what has been related, and with great Truth, as far as I could diſcover, touching that of *Spinoſa*; that he ended his Life in Solitude and great Tranquility, without manifeſting any external Signs of Uneaſineſs. This, I know, ſeem'd ſtrange to ſome Weak, but Pious Men, who had either ſeen or heard of very different and moſt dreadful Judgments of God againſt ſome that had thus denied him; and, ſecondly, that the Followers of this ſame *Spinoſa*, took an occaſion from thence to think, that the Opinions of their Maſter were not ſo unjuſtifiable.

able. But for the Satisfaction of the former, they ought to be told, that GOD working with Freedom, does not always puniſh Sins ſo viſibly in this Life; and as for the latter, if they have been converſant in the Writings of that *Atheiſt*, they may obſerve from thence, that *Spinoſa* is not ſo much to be looked upon for a learned Diſputant, as for ſuch a ſort of an *Atheiſt*, who with or without Conviction, was reſolved ſimply to adhere to his wicked Opinions; becauſe, as he thought, they would make him paſs his Life more agreeably.

I would not have it thought, that I ſay this of him out of Prejudice, but refer to his own Words, in his 34th Letter to the *Heer van Blyenbergh*; where he ſays, firſt, that he does not underſtand the Holy Scriptures, and entirely acquieſces in the Suggeſtions of his own Underſtanding; and then (inſtead of proving the Certainty thereof, which would have become a true Philoſopher to have done upon ſuch an occaſion) he proceeds thus, in a very unworthy Manner, to ſpeak to ſome Body that is ſeeking after Truth: *And altho' what I have already advanced concerning the natural Underſtanding, ſhould appear to be falſe; yet I am happy, whilſt I enjoy my Opinion, and paſs my Life eaſily, merrily, and pleaſantly, without Tears and Sighs*, &c. Now let wiſe Men judge, whether theſe Words ſhew a Philoſopher ſeeking after Truth, or an obſtinate *Atheiſt* that will not be convinced, leaſt it ſhould ſpoil his Mirth: It cannot therefore be denied, that GOD may ſuffer a ſtubborn Blaſphemer to fall away ſo far, that by perſiſting a long time in his Errors, he becomes at laſt entirely blind, and ſo remains, till the impending Wrath of God ſhall open his Eyes.

It is, moreover, very certain, that to the end he might not be diſturbed (I mean *Spinoſa*) he would

would not admit of any Diſcourſe, whilſt he lay upon his Sick and Death-bed, with any Body about the State of Men after this Life, and the Certainty or Uncertainty of his own Opinions; which alſo does not look like the real Convictions of a true Philoſopher: For tho' his Judgment might be ſo weaken'd by the Violence of his Sickneſs, that he could not well weigh nor anſwer the Reaſons and Objections that might be brought againſt him to his own Satisfaction; it was nevertheleſs true, upon his Principles, that he would not therefore be the more unhappy after his Death; but only that he could not have flatter'd and delighted himſelf with the Honour of paſſing for a greater *Free-thinker* than other Men.

Laſtly, I may here add, that one of his moſt particular Friends and Diſciples (well known to me in my Youth) who always adher'd to his Opinions, and maintain'd them, when he durſt, with great Accuteneſs, being a Man of very good Parts, lying upon his Sick-bed, and remaining there in a long Silence and Indolence, in Imitation of his Maſter, did at laſt burſt out in theſe dreadful Expreſſions, *That he now believed all that he had formerly denied, but that it was too late for him to hope for Mercy.* This was related to me, concerning the dreadful End of this Man, with all its Circumſtances, by a certain learned Gentleman, who knew that I having been acquainted a great many Years with the Opinions of that unfortunate Creature, and hearing of his Death, ſhould be deſirous to be informed of the Circumſtances thereof.

Now whether the Followers of *Spinoſa*, after having well conſider'd all that has been ſaid concerning the laſt End of their Maſter, have any Grounds for their Indolence and Indifferency, I

leave it to themſelves to conſider; provided they will do it without Paſſion and Partiality.

SECT. VIII. *The third Cauſe is Ignorance.*

A THIRD Cauſe of theſe deplorable Opinions ſeems to be, in ſome Men, a *downright Ignorance.* Accordingly I have met with ſome, who having never exerciſed their Underſtandings in examining Matters, have blindly followed their Inclinations in all things, ſo far as their Opportunities, which were few enough, would give them leave; and who being asked, what they thought of the *World*, and of its *Beginning?* openly denied that a God had made it.

I knew one of this ſort, who, after having abandon'd himſelf to Drunkenneſs for many Years, and paſſed his ignorant and brutiſh Life in theſe deſtructive Notions, died in the ſame; at leaſt it appeared ſo to them that attended him during his laſt Illneſs, and that related it to me.

I met alſo with another that might juſtly be ranked among the Number of theſe ignorant Perſons, who tho' he was outwardly a regular and ſober Perſon, yet when he was in the Company of thoſe that were not very averſe to his Opinions, did not ſcruple to ſpeak out plainly, and to affirm, that every thing *was from Nature* (this was his Expreſſion) *ſo as it is:* And when he was preſſed more cloſely to explain himſelf, alledged no other Reaſon, than that it appeared ſo to him, and that he could not conceive it otherwiſe; affecting, at the ſame time, under this Darkneſs and Ignorance a certain Haughtineſs, as if his Underſtanding was much ſuperior to that of others.

Sect. IX. *Means to prevent this Evil.*

Now, for the Converſion of this Sort of *Atheiſts*, ſince the beſt *Metaphyſical* Arguments make no Impreſſion on them, foraſmuch as they do not conceive them, nor will give themſelves the Trouble to ſtudy them, nothing ſeems to me more uſeful than to ſet before them ſuch Proofs as are only founded in thoſe common Experiments, obvious to every Man's Sight; and I know that one of this laſt Sort, who could not eaſily be induced to diſcover any Weakneſs or Doubts in his Opinions, was thereby obliged to acknowledge, that ſuch Proofs made him a little uneaſie.

Sect. X. *The fourth Cauſe is too great a Conceit of one's own Wiſdom.*

The Fourth Cauſe of *Atheiſm*, as far as my Obſervations and Experience reach, proceeds from *a too great Conceit of our own Wiſdom, and from an implicit admitting that to be Truth, which we are wont to deduce from our own Ideas or Notions.* And ſome Men are apt to advance ſuch their Notions with great Arrogancy, as well concerning the Divine Attributes and Properties, as about the ſmalleſt Appearances in the Creatures: In ſhort, they except nothing, and pretend to reduce every thing to an infallible Rule of Poſſibility and Impoſſibility, Truth and Falſhood, Good and Evil.

This is the moſt dangerous Kind of all: *Firſt*, Becauſe they deny every thing that they do not conceive; and therefore all Divine Revelation (which is above their Underſtanding) is not only rejected by them, but ridicul'd alſo. *Secondly*, Becauſe they have the greateſt Opportunity to ſupport

their Errors with ſpecious and plauſible Arguments, and to evade the Force of thoſe Objections that are brought againſt them, which they immediately make uſe of as ſoon as their Adverſary commits the leaſt Overſight or Blunder. *Thirdly*, Becauſe many of them, in their Converſation, do aſſume an External Appearance of Morality, and other Social Virtues, whereby they ſometimes acquire a certain Eſteem with the Ignorant, which may be of dangerous Conſequence; the rather, becauſe divers of them having learned the Elements of *Euclid*, *Algebra*, and other ſpeculative Parts of the *Mathematicks*, paſs amongſt the Unknowing for great *Mathematicians*; which Title does really no more belong to them, than that of a great Philoſopher to one that underſtands nothing but a little *Logick*; ſince People may be very well experienced in theſe Ideal or Notional Sciences, and yet be Maſters of very little, or no Knowledge at all, in Things that actually exiſt and come to paſs.

But we muſt not from hence conclude, that ſuch noble Studies do of themſelves lead thoſe miſerable Men into ſuch erroneous Opinions; for theſe, in many Caſes, open the Way *to the Diſcovery of the Wiſdom of God in the Works of the Creation*, to which we could not otherwiſe attain: On the contrary, they are exceeding uſeful, unleſs when miſapply'd by theſe half-learned Men, who being puffed up with a little Knowledge, fancy they know every Thing, and deſpiſe all thoſe who do not juſt underſtand as much as they themſelves about *Lines* and *Quantities*, tho' they be much wiſer, and more judicious in other Kinds of Learning.

SECT. XI. Spinoſa *briefly confuted.*

THUS we find at preſent, that in order to make even *Atheiſtical* Writings to paſs for uncontroverted Truths, the Authors thereof have endeavour'd to give them the Form of Mathematical Demonſtrations. A remarkable Inſtance of which may be ſeen in the Book of *Spinoſa*, which has for that Reaſon gained ſo much Credit with many of theſe unhappy Perſons; becauſe thoſe who do not rightly underſtand the *Mathematicks*, judge from the External Appearances, that what is laid down therein is deduced from juſt *Mathematical* Principles.

Perhaps we may hereafter find an Opportunity more fully to ſhew the Miſtakes that are there advanced under the Name of *Demonſtrations*, when we ſhall compare 'em with ſuch as are truly *Mathematical.*

To ſay a Word or two thereof *en paſſant*:

1. There are two Kinds of Objects, about which the *Mathematicians* do treat or employ themſelves, *viz.* Ideas ſimply conſidered as ſuch, and Ideas of Things really exiſting; that is, to ſpeak more clearly, *Mathematicians* diſcourſe either only about their Ideas, or elſe about Things that are really exiſting out of their Ideas.

2. The firſt Manner is ſeen in the *Speculative Geometry*, ſuch as the Elements of *Euclid*, *Algebra*, *&c.* where they conceive a Point as ſomething that has no Parts, a Line without Breadth, *&c.* So likewiſe they here conſider Magnitudes, which have more than three Dimenſions, *&c.* which every Body knows are only certain Ways of our Conceptions, having no real Exiſtence out of them.

3. The ſecond Kind of Object occurs in *Aſtronomy*, *Opticks*, *&c.* where things are conſidered, which, beſides our Ideas of them, have a real Exiſtence in themſelves.

4. The Foundation of the Firſt, beſides *Axioms*, are *Definitions*, in which they deſcribe their Ideas, without troubling themſelves whether there is any thing really exiſting that agrees therewith: Inſtances of which we have juſt now given: Accordingly it is with them a Truth, that *the three Angles of a Triangle, are equal to two Right ones*, and wou'd ſtill be ſo, altho' every Thing in the World were circular, and that there were not really ſuch a Thing as a Triangle.

5. The other way is founded upon Experiments and Diſcoveries, which either they themſelves, or other creditable Perſons make, of Things which are out of their Ideas, and ſomething more than meer Conceptions. Thus a good *Aſtronomer* lays down for the Foundation of his Science, that which he, or thoſe whom he can believe, have experimentally diſcover'd, namely, that there is really ſuch a Thing as a *Globe* of the *Earth*, a *Sun*, a viſible *Moon*, five *Planets*, ſome of which have their *Satellites*, or Bodies circulating about them, and a great Number of fix'd *Stars*; but does by no means extend his Imagination or Fancy to the Suppoſition of other Worlds, and other ſorts of Bodies; as for Inſtance, that there are ten Suns, a hundred Moons, a thouſand Planets, and a very few fixed Stars; of which imaginary Worlds, he might nevertheleſs bring a great many Proofs, which according to the firſt Way of arguing, we may allow to be Mathematical enough, but when adapted to the Things themſelves would appear to be entirely falſe.

6. Now thoſe that have read and underſtood *Spinoſa*, are ſenſible that he only lays down his own

own Ideas and Notions for the Foundation of every thing, which therefore needs not to be farther proved here: From whence it may appear to every one, that he applies this manner of diſcovering Truths prepoſterouſly to Things really exiſting, of which true *Mathematicians* never make uſe, but only about their own Ideas; wherefore the whole Series of ſo many Hypotheſes and pretended Demonſtrations in *Spinoſa*'s Book (tho' he ſhould argue rightly upon thoſe Principles, of which, however, the contrary may be proved in many Caſes) do repreſent nothing elſe to us than only the Properties of thoſe Imaginations or Conceptions, which that unhappy Author had formed in himſelf; nor can any Man thereby conclude any thing more from the Things themſelves, than an Aſtronomer can do, who advances his own Notions for the true Structure of the Heavens.

7. So that from this Miſtake alone the Weakneſs of all *Spinoſa*'s Arguments appear at one View, and how little his Way of Demonſtrating agrees with that of true Mathematicians.

Sect. XII. *The Remedies againſt this Fourth Cauſe.*

But to return from this Digreſſion: Since theſe unhappy Philoſophers aſcribe ſo much to their own Underſtanding, and do exert their whole Strength to oppoſe the Weight of all *Metaphyſical* Arguments, tho' they are ſupported by ſtrong Reaſons, the only Way that I have ever ſeen uſed with Succeſs to overthrow their proud Fancies, that they can conceive every Thing, and to ſhew them the Narrowneſs of their Underſtandings (which is particularly neceſſary to their Converſion) is this; let them be brought into a *Chymical Laboratory*, or other Places where People are wont to make Phyſical Experiments, ſuch as are not

commonly known to every Body, and let them be asked what will be the Reſult of ſuch, or ſuch an Operation, purſuant to their own Notions and Conceptions? In which, if they miſtake, and Things appear quite contrary to what they expected, they can have no Subterfuge or Evaſion, but will be compell'd to acknowledge, that their Underſtandings have been very little converſant upon Objects really exiſting: And in caſe they themſelves are verſed in natural Experiments, let them be deſired to contemplate, without Prejudice, the Manner how every thing they ſee comes to paſs, and to think whether the Power and Wiſdom of the Great Creator and Ruler of all Things, does not appear as inconteſtably in them, as the Judgment and Skill of any Artificer in the Machines that he has invented.

Sect. XIII. *The firſt Steps to Atheiſm are Prejudices.*

Beſides the above-mention'd four Cauſes, there do occur to me other Steps or Inducements to *Atheiſm*; which tho' they cannot properly be eſteem'd *Cauſes*, as the former, yet they are uſed by many as Steps towards it; and tho' they do not always bring Men to deny, yet they do at leaſt tempt them to doubt of the higheſt Truths.

The firſt Sort of theſe are our *Prejudices*, ſome of which we bring into the World along with us, as others proceed from the Slaviſhneſs of our External Senſes. Thus Men fancy, for Inſtance, that the Sun is no bigger than a Trencher, or little Diſh, and that its Diſtance from us is very ſmall: In the ſame Manner the Planets appear to us as little contemptible Things. This being deeply impreſſed in our Minds, tempts us to look upon the Greatneſs of God with very ſmall Reſpect or Reverence; ſince from ſuch Appearances

wo

we judge there was very little Power neceſſary to form and govern them: Whereas, if we did (as we ought to do) conſider the World in its immeaſurable Expanſion, the Sun as a Globe of Fire, of a moſt amazing Bigneſs, and the Planets as ſo many thouſand Times bigger than this whole Earth, they would excite in us quite other Sorts of Conceptions, and make us ſtand abaſhed at the great Power of our adorable Creator and Ruler.

Another *Prejudice*, which hinders us from obſerving the Wiſdom of GOD in the Direction of the viſible World, is, that when we cannot ſee either *Bodies* or *Motions*, we are preſently apt to fancy that there is nothing either of Body or Motion, but what we can ſee with our own Eyes; for believing that that which is in Reſt will always remain ſo, and that nothing elſe is requiſite to continue it, it ſeems to us as if neither Power nor Direction were neceſſary thereto, and that Fancy inſenſibly leads us either to deny altogether, or at leaſt hardly to acknowledge any Divine Providence in thoſe Things and Places. Thus do many imagine, that in a Chamber, for Inſtance, which is full of Light and Air, all Things are ſtill and quiet, and conſequently, that there is no Want in that Place of any Power and Wiſdom to preſerve us from Accidents: But if one were to repreſent to ſuch Men the incredible Strength of the Air ſurrounding them, and that without the Intervention of a Wiſe and Powerful Being, which continually reſtrains its reſiſtleſs Violence by a Counterpoiſe and Ballance of Force, they would be cruſhed to Pieces in an inſtant; and ſo if they were made to conceive the terrible Motions of Light, which unleſs it were govern'd by certain Laws, by which its Rays are ſeparated and ſcatter'd, would, in the Space of a few Minutes, put this whole Globe

of

of the Earth in a devouring Conflagration; who could doubt, if he had the leaſt Spark of Reaſon in him, that he has not from hence the juſteſt Cauſe imaginable to praiſe and extol the *Greatneſs*, *Power* and *Wiſdom* of a GOD, who only preſerves us from all thoſe Dangers, and hinders us from periſhing in ſo miſerable a Manner.

SECT. XIV. *The Means to cure Men of theſe Prejudices.*

NOW in order to be cured of theſe *Prejudices*, we are taught, by what has been already ſaid, that it is neceſſary to enquire experimentally into the true State and Nature of Things, and afterwards to form a right Notion of them from thoſe Proofs which are drawn from undeniable Experiments, and frequently to meditate upon the ſame; this will make us, as it were, feel with our Hands the Power of the great Ruler of all Things, if we do but carefully attend thereto.

SECT. XV. *The ſecond Step, the abſurd or wrong Manner of deſcribing Nature.*

THE ſecond Inducement or Inlet to *Atheiſm* (tho' upon many Occaſions it is in it ſelf uſeful and neceſſary, but by an imprudent Application ſerves to corrupt Mens Underſtandings) is an *abſurd and falſe Manner of Philoſophiſing*, or rather *of Inſtructing any one in the Knowledge of Nature*; under which Head I refer, in the firſt Place, to ſuch ſort of Books, as perhaps are not written with an evil Deſign, but which, however, if you will believe the Authors themſelves, pretend to give a true Notion of the whole Frame and Conſtruction of the World, and of all its viſible and inviſible Parts without Exception; deſcribing,

after

after their Manner, with as much Aſſurance as if they had been preſent, and were GOD ALMIGHTY's Cabinet-Council, how he made the World, how he put all Things together, and how he has produced and continued the Motion thereof; and (which I have often been ſurprized to hear from the Mouths of ſuch as were otherwiſe Men of good Senſe) even how every Thing between the Circumference of the ſtarry Heavens, and the Centre thereof, were made in the Beginning of the World.

Now, if ſo be that any Man ſhould fall into ſuch an unhappy Opinion, as to receive for Truth all that he finds written in ſuch Books, how can he do otherwiſe than believe, that there was no more Wiſdom requiſite to bring this glorious Frame of the World into ſuch a beautiful Order as we ſee it, and to continue it in the ſame, than what the Authors of ſuch Books were Maſters of? And how far this may in time miſlead a great many young and unexperienced Perſons, and divert them from that Wonder and Reverence which is due to the endleſs Wiſdom of GOD, it is eaſie to imagine, and ſome have found by fatal Experience.

SECT. XVI. *The Inconveniencies of Deducing every Thing from an Hypotheſis.*

TO this wrong Way of Thinking may be aſcribed *the Manner of Deducing all the Phænomena of Nature from a certain Hypotheſis.* Now it will be very eaſie to ſhew, how many Occaſions of falling into irreverent Thoughts of GOD's All-ruling Providence, this imaginary Manner of Philoſophiſing furniſhes Men with; ſince ſome Underſtandings obſerving that it coſts them more Pains to comprehend any notable *Mathematical* Propoſition, or to ſolv

Algebraical Queſtion, than to repreſent to themſelves the Cauſes and Operations of all that belongs to the viſible World, upon the Foot of ſuch an Hypotheſis; the great Work of the whole Creation appears to them more eaſily to be conceived than ſome of the Inventions of the *Mathematicians*: From whence therefore a tacit Conſequence is deduced by little and little, that towards the Conſtruction and Government of the Heavens and the Earth, leſs Wiſdom is required, than what many Perſons, whom they look upon to be great *Mathematicians*, are really poſſeſſed of; and this does proportionably diminiſh the Reverence which they ought to have for the Wiſdom of their Great Creator; the Loſs of which is oftentimes one Stone of Offence, upon which ſome of my Acquaintance have firſt ſtumbled, and afterwards fallen.

Thoſe who have been intangled in ſuch a Labyrinth, are wont zealouſly to engage themſelves yet farther therein, and, againſt all the Convictions of contrary Experiments, to ſupport their Hypotheſes with all their Might; perſwading themſelves with a ſecret Pleaſure, that without beſtowing any Trouble or Charges upon Trials, their own Hypotheſes will ſerve them for a true Key to open the moſt hidden Secrets of Nature: And to the end that they may not be brought into any Doubtings concerning the ſame, from this Obſervation, that there may be more than one Hypotheſis, from which the ſame Effects are deducible (as is known in *Aſtronomy* and other Caſes) many of 'em are accuſtomed to lay down this Maxim, *That an Hypotheſis may be ſafely maintained to be the moſt true, becauſe it is the moſt ſimple*; which Argument is of much the ſame Force, as if any one ſeeing a Watch going in a Chamber, pretends to have rightly proved, that the ſame is moved by a

Weight, and not by a *Spring*, becauſe the former of theſe appears to be the moſt plain and ſimple.

Finally, this Hypothetical Philoſophy is ſo much the more prejudicial, that it neceſſarily obliges Men to fancy that they have attained to a fundamental Knowledge of even the moſt principal Things that occur in Nature; ſince every one muſt expect to be look'd upon as a compleat Fool, in caſe he preſumed to find out an Hypotheſis which was proper to account for Phænomena wholly unknown to him; foraſmuch as any Alteration in the *Phænomena* muſt likewiſe neceſſarily produce Alterations in the *Hypotheſis*; and this cannot be done without occaſioning too mean an Opinion of the Works of our Great Creator, and even of the Creator himſelf.

To diſentangle themſelves out of ſuch a Labyrinth, more Pains are requiſite than a Man who has never tried it can perhaps imagine; eſpecially, if ſuch Perſons be pretty far embarked in theſe Studies. Every one who has had the Trial of it, knows how mortifying it is to give up an Hypotheſis which he has believed and maintained for many Years to be true, upon which he has pored and meditated ſo many Nights, with which he has blotted ſo much Paper, and for the ſake of it, ran thro' ſo many Books; and, laſtly, by the help of which, he fancies to himſelf, that he is arrived to the Top of all Wiſdom, or at leaſt, that he ſhall ſoon reach it. He that has a mind to ſee an Inſtance thereof, let him peruſe the Preface to the *Anatomy of the Brain*, by the Learned Dr. *Willis*.

SECT.

Sect. XVII. *The Remedies againſt this Evil.*

Now, in order to prevent the being ſeduced by this manner of Philoſophiſing by Hypotheſes only, it is firſt neceſſary, that Men ſhould not dwell too long upon thoſe ſpeculative Studies, tho' they ſhould ſilently flatter us with the Fruitfulneſs of ſuch Hypotheſes, and the Repreſentation of the Greatneſs of our Underſtanding; but we ſhould give our ſelves up to actual Experiments, not enquiring into the Opinions of Men, but into the Nature of Things themſelves, and ſatisfy our ſelves of the *Power* and *Wiſdom* of the adorable Creator, after a quite different and more poſitive Manner, and learn how great is the difference between *knowing* any thing *Experimentally*, and *gueſſing* at it *Hypothetically*.

Sect. XVIII. *Another Remedy.*

Another Way whereby we may ſecure our ſelves againſt the Evil Conſequences of this kind of Studies, is, when we are asked about Things of which our Ideas are not ſufficiently clear, to anſwer calmly, and without bluſhing, *I know not*; and by no means pretending by this, or that uncertain, or undemonſtrated Hypotheſis, to give an Account thereof, for fear of loſing the reſpect that belongs to us. This will prevent the naturally high Conceptions which we have of our own Underſtanding, from throwing Duſt in our Eyes; and it is the true Means to make us think humbly of our ſelves, and to contemplate with Wonder the Works of our great Creator.

I know very well how hard a Thing it is for one, who has an Opinion of the Fame of his own Learning, and who has devoted himſelf to theſe Studies,

Studies, to be brought to a frank Confeſſion, *that there is ſomething which he does not know*; the rather, becauſe this or that Hypotheſis may ſeem always to furniſh him with a Back-door to evade ſuch an Anſwer. But tho' this be a little ſhocking at firſt, yet the Man who is truly knowing, will ſoon bring himſelf to confeſs, that there is ſuch a Thing as an *Eruditum Neſcire*, or a Learned Ignorance, *viz.* in ſuch a one, who knowing at firſt what Great Men have pronounced about a certain Thing, yet can ſhew experimentally, that their Opinions are not to be received for Truth, and being himſelf asked about it, confeſſes his Ignorance without Reluctancy. This will by no means leſſen the Eſteem which he has acquired by his Learning in the Opinion of wiſe Men; and yet will produce this Fruit, that quite different from many unhappy Atheiſts, who fall into Error, thro' a Conceit of knowing all Things, he will acknowledge, that the Wiſdom of God, as it ſhines out in the Phænomena of the World, does far ſurpaſs his own weak Underſtanding.

SECT. XIX. *The Uſe of Hypotheſes.*

WE would not, however, that Men ſhould believe from hence, that we reject all Hypotheſes as quite unneceſſary; ſince, if they be properly uſed, they are of great Service in many Caſes; not only becauſe they reduce the Thoughts of an Enquirer into a more regular Compaſs, and hinder them from rambling out too far; but chiefly, becauſe they are of a particular Advantage in directing the Judgments of young People, and ſetting them a Pattern how they may afterwards Diſcourſe and Argue from Experiments; provided it be done with ſuch Prudence and Caution as may lead them to make a juſt Diſtinction between the

the one and the other: Wherefore, it is commendable enough in thoſe Perſons, whoſe Deſign and Duty requires them to direct Youth in the Courſe of their Studies.

SECT. XX. *A Third Inducement to Atheiſm, to admit of no Final Cauſes.*

I Do not know whether I ſhould not lay down this for another Step or Inducement to *Atheiſm*, *viz.* the Maxim that ſome have taken up and maintained, *That in Philoſophiſing, no Notice is to be taken of previous Deſigns or final Cauſes.*

I do not here blame thoſe Philoſophers who affirm, that in the Study of Nature, where Men enquire how every thing *Is*, *Acts*, and *Moves*, the Contemplation of *Final Cauſes* have properly no Place; and I readily agree, that when one is asked, *How does ſuch a Thing happen?* it is abſurd to anſwer, *That it happens for ſuch an End or Purpoſe.* But this is nevertheleſs true, that if ſuch a Rule be admitted without any Reſtrictions, it may ſerve to miſlead Men into a raw Conception, that all Things are made without a View or Deſign, and that *meer Chance*, or *unknown Cauſes* take place in the World: Yea, the Queſtion, *Why any thing happens?* or, *To what End it is ſerviceable?* ought not to be entirely baniſhed out of Philoſophy, as unworthy of great Underſtandings; tho' we ſhould allow, at the ſame time, that it does not properly belong to that Part of Phyſicks which contemplates the operating Cauſes; this, I believe, every Body will grant, who having enquired into Natural Things, has, with Pleaſure, ſeen the Uſes thereof, and the Service which they render both to the World, and to Men.

It

It is true, indeed, that in the Modern Philoſophy, this is not taught abſtractly from other Things; but as in *Pneumatics*, the Properties of Spirits; in *Phyſics*, thoſe of Bodies; in *Mechanics*, the Laws of Motion; in *Aſtronomy*, the Properties of the Heavenly Bodies; in the *Optics*, thoſe of Light and Viſion are handled; ſo it occurs to me, and I think not without Reaſon, (if one ſhould treat expreſly about the Deſigns and wiſe Ends of the Creator, and ſhew the ſame from the State of Things, and from their Uſes) that a *Scopology*, or *Study of Ends*, would prove one of the moſt exalted Parts of Philoſophy, and might contribute, not only to convince many (who otherwiſe forget GOD) of their Obligations, and juſt Gratitude to their Great Maker; but likewiſe to render Famous to all Poſterity, ſuch as have been diligent and ſucceſsful in diſcovering new Uſes of Things, tho' the Things themſelves have been known long before. Thus we ſee, that *Harvey*, in the Diſcovery of the *Circulation* of the *Blood*, found out a Uſe that was never before known, of the *Heart*, *Veins*, and *Arteries*; ſo did *Malpighi*, of ſeveral of the Parts of *Animals* and *Plants*; ſo did *Borelli*, of the *Inſtruments* of *Motions*; whereby they have all of them render'd their Names honourable to future Generations.

SECT. XXI. *The Remedies againſt this wrong Notion.*

How much the Experimental Examination of the Creatures is uſeful to avoid the Evil Conſequence of ſuch raſh Principles, the nice and exact Enquirers in this Age have ſhewn us; eſpecially the Anatomiſts, who are wont, to all the Deſcriptions they have given us of Bodies, ex-

preſly to ſubjoin the *Ends* and *Deſigns* for which they are ſo compoſed, together with their Uſes; and very often expatiate from thence, upon the Praiſes of the *Wiſdom* and *Goodneſs* of that *Being* which has formed them; of which the abovemention'd laudable Gentlemen, *Harvey*, *Malpighi*, *Borelli*, and a great Number more, are illuſtrious Examples.

SECT. XXII. *The Fourth Inducement is Diſputes.*

THE Fourth Inducement, which indeed does not of it ſelf always beget *Atheiſm*, but yet inſenſibly leads to it, and even hinders Men from being convinced of the moſt Fundamental and Divine Truths, is thoſe numerous Diſputes that are ſtarted concerning them, and of which there is never any End.

This need not be proved to thoſe that are acquainted with the Diviſions among the Ancient and Modern Philoſophers, who, tho' they join perhaps on all hands, to defend the Being and Attributes of a God againſt *Atheiſts*, yet do not agree in (but frequently reject) the Arguments brought by one another to prove the ſame. By ſuch continual Differences, (eſpecially if Paſſion and ill Language be mix'd therewith) Men that are not ſettled in their Principles, are rendered yet more unſtable and doubting; and there is too great a Handle given to ſuch as deny a God, to maintain, with ſome kind of Probability, that all that has been ſaid and believed concerning Him, is not attended with ſo much Certainty as it ought.

SECT.

SECT. XXIII. *Means to prevent the ſame.*

NOw to the end that we ſhould not be ſubject to thoſe Diſputes, and that a total Stop may be put to them, we ſhall here propoſe a Means, which we hope may ſeem proper for that purpoſe; which is ſeriouſly to ſet about enquiring, wherein the juſt Characteriſtick, or Mark of the Truth or Falſity of a *Propoſition* or *Enunciation* conſiſts: For if People did but agree in this one Thing, they might, without any farther Caviling or Diſputing, judge with Certainty of a Propoſition, in caſe it was accompanied with the right Marks of Truth, that it was True; and if it had the contrary Marks, they might pronounce it Falſe; and again, if thoſe Marks were obſcure on both Sides, they would declare it doubtful and uncertain.

But ſince it is more to be wiſhed than expected, that the Diſagreement among Philoſophers, about the Characteriſticks of Truth, will ever be entirely laid aſide; the beſt way that I can think of to avoid, and put an end to Diſputes, is to make uſe of ſuch Proofs of the Truth or Falſity of a Propoſition, that have their Foundation, not ſo much in Arguments, as in undeniable Experiments, as often as it can be done.

Men muſt be well confirmed in what has been here laid down, ſince we have a clear Proof thereof in our Modern Phyſicks, it being known to every one, at leaſt allowed by the moſt Learned, that in order to be aſſured of the Truth of a Poſition in this Science, the ſame muſt be demonſtrated by Experiments; and it has been found that the greateſt Men of this laſt Age, have allowed Experiments to be the only Characteriſticks of Truth, and that an end has been

put by them to many Diſputes, and that very few new ones have ariſen in Natural Philoſophy, which have not thereby been quaſhed almoſt as ſoon as they appeared. Thus all the Debates, Whether the Blood circulates or not? Whether Water riſes in a Pump by the Preſſure of the Air, or not? Whether Nature can ſuffer a *Vacuum*, or empty Space or not? and a great many others, about which Men have ſo long wrangled, are now entirely removed by unanſwerable Experiments; and the Truth of the former, and conſequently the Falſity of the latter, are proved even by Ocular Demonſtration: And ſince the Motion, or Reſt, of the Sun, has not yet been determined by any Experimental Proofs the moſt famous Aſtronomers have yet made, that muſt be rank'd among thoſe Things that are to be accounted uncertain: But of this we ſhall treat more largely when we come to the Contemplation of *Unknown* or *Undiſcover'd Things*.

Sect. XXIV. *The Abuſe of Academical Diſputes.*

Before I quit the Subject of Diſputes, I find my ſelf obliged to repreſent, with great Submiſſion, to thoſe Gentlemen in whoſe Power it is to reform thoſe Abuſes, (in caſe this Book ſhould ever have the Honour to be peruſed by them) ſomething that may prevent the ſame; for tho' Diſputes may have been at firſt eſtabliſhed and made uſe of in ſome Univerſities with a good View, and for whetting the Underſtanding; yet they have given occaſion to many to Cavil about the moſt weighty Truths; inſomuch, that you ſhall often hear them in publick Diſputes, arguing with as little Reſpect and Humility about the *Being of a God*, as concerning the vaineſt and moſt frivolous *Entia Rationis*, or Chimera's of the Brain;

Brain; and you ſhall ſee them indifferently maintaining a *Theſis* of the *Great God of Heaven and Earth*, and immediately after diſcourſing of a *Vacuum*, or of *imaginary Space*; and without any diſtinction of Reverence in the one Caſe or in the other. This inſenſibly engages them in a ſad Cuſtom of vainly uſing the tremendous Name of God very frequently, and without the leaſt Devotion, and of making that moſt ſupreme and adorable Being, which ought not to be thought of, much leſs named without Emotion, the Object of their wanton Speculations. What Evils this has been the occaſion of in ſome, is very obvious to thoſe who have experimented how much that Natural Contempt, which they feel in their Hearts (without Reaſon indeed) for Divine Things, has been thereby increaſed.

I leave it to thoſe Gentlemen to whom the Superintendency over the Univerſities is intruſted, to find out Means, according to their great Wiſdom, for obviating theſe Abuſes; only, humbly offering it to their Conſideration, whether the Weight of this Great Affair, does not loudly call for an Anſwer to the following Queſtions: *Firſt*, Whether it ſhould not be forbid henceforwards, that the Name and Attributes of the moſt *adorable Deity*, ſhould be made uſe of only as Means for exerciſing young Underſtandings, and furniſhing Matters for Diſpute, with which *Philoſophy* does, beſides this, ſufficiently abound. *Secondly*, That thoſe Truths, concerning GOD and his Perfections in the *Metaphyſicks* and *Doctrine of Spirits*, wherewith Youth are to be inſtructed, be not any longer handled in Publick Diſputations, but in private Aſſemblies only, and (as it is the Cuſtom in *Divinity*) after having poured out a Prayer to GOD, with that becoming Humility and Reverence which is due to the Great LORD

of all Things; the rather, becauſe moſt commonly young People only (who are of an Age in which the Judgments are moſt eaſily byaſs'd or corrupted, and the Paſſions do moſt prevail) are the Hearers of theſe Lectures and Diſputations. By ſuch Means we might begin to hope, that the Danger which ariſes from this diſrepectful manner of Diſputing, may be hinder'd from taking Root in young Minds; and that every body might be convinced by the pious Examples of the Academical Teachers, and reverend handling of theſe Matters, that Learned Men do likewiſe fear GOD; the contrary to which is maintain'd by many *Atheiſts*, and is one Method whereby they ſtifle the Remorſes of their own Conſcience.

SECT. XXV. *The Fifth Inducement, Inattention or Heedleſneſs.*

BESIDES what has been already ſaid, there is ſtill ſomething more, which indeed does not carry Men into compleat *Atheiſm*, and yet does very much contribute to hinder them from diſcovering GOD in his Works; inſomuch, that many People do, upon that Account, paſs their Lives without obſerving, at leaſt without being convinced, of theſe weighty Matters; and that is a *Natural Sloth and Carleſneſs, or want of conſidering with proper Attention, thoſe Things in which the Perfections of the Creator ſhine out ſo brightly.* We are all deſirous to ſatisfy our Curioſity, and therefore we earneſtly contemplate, and oftentimes enquire into the Cauſes of all thoſe Things which we take for Wonders; becauſe the Manner in which they happen is unknown to us. If Comets or *Parhelia* appear, if the Sun or Moon happen to be eclipſed, how eagerly are they obſerved both by

by Learned and Unlearned Men; and yet we daily ſee the Sun riſe, and the Moon and Stars ſhewing themſelves; the Earth and Trees cover'd with Flowers and Fruits; Humane Creatures and Beaſts procreating, and a thouſand other Wonders, and remain very indifferent towards them all, without dwelling long enough upon the ſame, and obſerving them with that Care and Judgment we ought, or turning our Thoughts towards the firſt Cauſe and Author of all.

Methinks one might conclude, that the frequently repeated View of ſuch Things, each of which alone are wonderful in themſelves, ſhould make ſo much the ſtronger Impreſſion upon our Minds; and yet moſt commonly we experience the contrary. That this ſhould obtain in ignorant People is not ſo ſtrange; but it is much to be lamented, that ſuch a *Heedleſneſs* ſhould many times be found in thoſe, who do not want for good Underſtanding, and who are deſirous to paſs for Philoſophers. One might likewiſe allow it in ſuch as are not much accuſtomed to value or ſhew any reſpect for the Knowledge of a GOD, or the true Cauſe of all Things; but that others ſhould be ſo careleſs in this Matter, who are ſo well convinced of the Importance of this Enquiry, that it does not ſuffer them to be ſilent, but upon the leaſt occaſion do continually argue for it, (inſomuch that I have not been able to diſcover the Doubts in which they were, or had been) is a Thing that muſt needs appear unaccountable to every Body.

The Reader will not Diſpute the Truth of what I have here advanced, when I tell him, that I have been perſonally acquainted with ſome Men, who were formerly thus heedleſs, and altogether inſenſible of the Works of the Great Creator; but being afterwards brought to a more due At-

tention, were aſtoniſhed at themſelves, that thoſe very Things which a Wiſe Maker and Powerful Ruler did, as it were, cauſe them to feel with their Hands, which had been known to them ſo long before, which they had frequently meditated upon in their Studies, which they had read in the Works of other Men, and had often diſcourſed of them with others; ſhould not have carried their Thoughts up to a GOD, nor cauſed them to feel in themſelves the leaſt Conviction of his Being.

If Cuſtom be the occaſion thereof, which, becauſe we daily ſee ſo many Wonders, makes us receive them without any Impreſſion; one can only ſay, that it is by ſuch a Cuſtom we become quite Blind, and wholly Inſenſible.

SECT. XXVI. *Means to prevent ſuch Inattention.*

THE only Natural Means that I ever found effectual to render us more attentive to every Thing, is frequently to apply our ſelves to new Diſcoveries and Experiments, which appearing to us upon every Eſſay, to be New and Uncommon, do give us an occaſion of obſerving with Aſtoniſhment the *Wiſdom*, *Power* and *Goodneſs* of Him that Orders all Things after ſuch a manner; eſpecially, if we endeavour to wean our ſelves (which is here abſolutely neceſſary) from this our Natural Sloth, and continually join our Experiments, with theſe Obſervations.

This is not the Place to take notice of another and true Cauſe of our Blindneſs, which, in this reſpect, is ſo great as to hinder us from ſeeing the Perfections of GOD in the Works of the Creation, tho' they be daily before our Eyes; to wit, *the univerſal Corruption of Mankind*; becauſe this is only to be remedied by Prayers, and by the Grace

Grace of GOD it ſelf, but no ways by natural Means, which is what we are here chiefly concerned about.

SECT. XXVII. *Why we only make uſe of Proofs drawn from Natural Philoſophy.*

FROM all that has been already ſaid, it may be inferr'd, that the exact and experimental Obſervations of what we ſee in the World, is a demonſtrative Means, not only to obviate ſo many Cauſes and Inducements to *Atheiſm*, but likewiſe to attain to the Knowledge of a GOD and his Perfections by his Works; and let no Man think it ſtrange, that in the following Diſcourſes I make uſe of this Method, and not of other kind of Arguments, which are commonly called *Metaphyſical*.

The Reaſons that led me thereto are theſe:

Firſt, Becauſe many learned Perſons have unanſwerably confuted the *Atheiſts* after a *Metaphyſical* Manner, that is, ſuch a one as is built upon Reaſoning: The Proofs therefore, of this Kind, may be found in great abundance in their Writings.

Secondly, Becauſe Experience and Converſation with ſome of theſe unhappy Philoſophers, has taught me, that the Contemplations of GOD's Works, when one could bring 'em thereto, has induced ſome among them to alter their Sentiments, who for many Years had withſtood other Proofs; becauſe the Subtleneſs of their Underſtanding ſeemed to furniſh them always with a Handle to diſpute againſt *Metaphyſical* Arguments, and ſo left them ſtill diſſatisfied.

SECT.

SECT. XXVIII. *Becauſe* GOD *is pleaſed to make uſe of this Way in his Holy Word.*

THE Word of GOD does likewiſe give Teſtimony to this ſame Method in many Places of it: Thus we ſee St. *Paul* makes uſe of the Creatures for a Demonſtration of GOD's Eternal Exiſtence; Rom. i. 20. *The inviſible Things of him, from the Creation of the World, are clearly ſeen, being underſtood by the Things that are made, even his Eternal Power and Godhead.*

In the ſame Manner *David* relating the Works of GOD in a moſt ſublime and pathetical Strain, in ſeveral Verſes of the 104th *Pſalm*, proves from thence his great Wiſdom, ver. 24. *O Lord, how manifold are thy Works! in Wiſdom haſt thou made them all.*

Thus the GOD of Heaven does not command us to ſeek for Arguments from the Depths of Philoſophy, in order to ſee his Power, but only to turn our Eyes towards his Works; *Iſaiah* xl. 26. *Liſt up your Eyes on high, and behold who hath created theſe Things, that bringeth out their Hoſt by Number; he calleth them all by Names, by the Greatneſs of his Might, for that he is ſtrong in Power not one faileth.*

His Mercies are alſo ſhewn from his Actions in the 107th *Pſalm*. We likewiſe ſee the Almighty himſelf in the Book of *Job*, Chap xxxviii, xxxix, xl, & xli. making uſe of Proofs taken only from his Works, exhorting us, in many Places of his Holy Word, after the moſt earneſt Manner, thus to contemplate his Perfections in his Works. Thus we hear the Holy Ghoſt in the 107th *Pſal.* ver. 43. after having given a circumſtantial Relation of the Actions of GOD, finally making this Concluſion: *Who is wiſe and will obſerve thoſe things?*

Even

Even they ſhall underſtand the Loving-kindneſs of the Lord.

From whence it plainly appears, that towards ſuch wiſe Underſtanding, no feigned Hypotheſes, but an Obſervation of Things themſelves, which can only be made by Experiments, is required; for which Reaſon Men are wont even to this Time to beſtow the *Latin* Term of *Obſervations* upon what we find out by Experience.

And ſo great a Streſs is laid upon this Exhortation of knowing GOD by his Works, that thoſe who do not ſtudy them after that Manner, are pronounced Fooliſh, and void of Underſtanding; Pſal. xcii. 5, 6. *O Lord how great are they Works? and thy Thoughts are very deep: a brutiſh Man knoweth not, neither doth a Fool underſtand this*; for which Reaſon, the not enquiring into the ſame, is by the Spirit of God reckon'd among the Cauſes of *Atheiſm*; Pſal. x. 4. *The Wicked, thro' the Pride of his Countenance, will not ſeek after God: God is not in all his Thoughts.*

SECT. XXIX. *The General Proof or Demonſtration of a GOD.*

AFTER having fully comprehended all the foregoing, we might now have proceeded to the Contemplations of the World, and the Perfections of GOD, in the Compoſition, Parts and Motions thereof, were it not that what follows may yet ſeem to require, that we ſhould previouſly ſhew after what Manner, from the viſible World, and that which we ſee paſs therein, a Proof may be formed upon which we may rely and be aſſured, *Firſt*, That there is a GOD, that is to ſay, a Wiſe, Powerful and Gracious Maker and Director of all Things; And, *Secondly*, That the Bible (his revealed Word) is of a Supernatural and Divine Origin.

As

As to the Manner of Demonſtrating the Firſt, I ſhall, without entering into Deep Speculations, like ſome Philoſophers, ſeriouſly entreat every one, that with a compoſed Mind, and diveſting himſelf of his Paſſions and Prejudices, he would ſilently ſet down, and ſeriouſly conſider, *Firſt*, in caſe he ſhould ſee that

1. Not one, but a great many,
2. And various or different
3. Things entirely ignorant, or unknowing of all, and even of themſelves too:
4. Each of them frequently after a particular Manner
5. However always unchangeably, and obſerving the ſame Rule;
6. Do act and move not once, but upon many Occaſions and Times;
7. And not one of all them able to impart ſuch *Motion* to it ſelf;
8. Nor unleſs they thus come together of themſelves, can produce one ſingle Effect without their own Knowledge:
9. In the Production of which Effect or Thing, if ſome few Circumſtances only, or oftentimes but one ſingle one were wanting, it could not either be produced at all, or at leaſt not in its due Perfection;
10. Altho' that ſame Effect ſhould in it ſelf be of great Uſe and Service, and ſometimes of the utmoſt Importance.

Could he imagine otherwiſe, than that all theſe things are formed to that End, and brought together with that Deſign, to work ſuch an Effect as we obſerve to be produced by them?

And, *Secondly*,

Suppoſing this firſt to be true, ſince theſe things are in themſelves ignorant and unknowing of all that paſſes; whether every Body muſt not agree, that

that they are all produced, and made to concur by a wiſe and underſtanding Agent, who had ſuch an End and Deſign in his View? And whether any one can perſwade himſelf that meer Chance, and unknowing Laws of Nature, or other Cauſes ignorantly co-operating, could have Place herein, and could have directed and governed theſe Things in all their Circumſtances and Motions for ſuch a Purpoſe?

That this may be ſhewn after a more plain and not leſs certain Manner, let us apply to ſome particular Thing what has been juſt now advanced in general, and as it were in an abſtracted Manner; and let us ſuppoſe that in the middle of a ſandy Down, or in a Deſart and ſolitary Place, where few People are uſed to paſs, any one ſhould find a Watch, ſhewing the Hours, Minutes, and Days of the Months, and having examined the ſame, ſhould perceive ſo many different Wheels, nicely adapted by their Teeth to each other, and that one of them could not move without moving the reſt of the whole Machine; and ſhould farther obſerve, that thoſe Wheels are made of *Braſs*, in order to keep them from Ruſt; that the Spring is of *Steel*, no other Metal being ſo proper for that Purpoſe; that over the Hand there is placed a clear Glaſs; in the Space of which, if there were any other but a tranſparent Matter, he muſt be at the Pains of opening it every time to look upon the Hand: Beſides all which, he might diſcover in it a Hole, and exactly oppoſite thereto a little ſquare Pin: He would likewiſe ſee hanging to this ſame Watch a little Key compoſed of two Pieces, making a right Angle together; at the End of each of which there was a ſquare Hole ſo order'd, that one of them was exactly adapted to the little Pin in the ſaid Hole, which being applied thereto, a Chain would be wound up, and a Spring

a Spring bent, by which Means the Machine would be continued in Motion, which otherwiſe would be in an entire Reſt: He might alſo find, that the other ſquare Cavity, at the End of the little Key, was adapted to another Pin or Inſtrument, which being turned this Way or that, makes the Hand move faſter or ſlower. At the other End of this little Key there would be a flat Handle, which being moveable therein, might give him the Conveniency, that in the Winding it up he ſhould not be obliged to take hold of it at every Turn of his Fingers.

Laſtly, He would perceive, that if there were any Defect either in the Wheels, Spring, or any other Parts of the Watch; or if they had been put together after any other Manner, the whole Watch would have been entirely uſeleſs.

Now the Queſtion is, in order to form a Kind of Demonſtration from hence, *Firſt*, Whether any Body can imagine, that ſuch a Watch among other Purpoſes, to which it might perhaps be ſerviceable, was not likewiſe made for this End, that it ſhould ſhew the Hours, Minutes, and Day of the Month. *Secondly*, Whether he ſhould make the leaſt Scruple to admit it for a Truth, that ſuch a Machine was made and put together by an underſtanding Artificer for this very Purpoſe, who, when he made it himſelf, knew that, and to what End he had made it.

And *Thirdly*, Whether it be poſſible that he can perſwade himſelf that this Watch, with all belonging to it, the Niceneſs of its Make, Figure of ſo many Parts, and other Contrivances for ſhewing the Time, could have acquired its Being and Form by meer Chance only, which operated indifferently one way or another, and without any certain Rule or Direction?

Or

Or otherwiſe, whether he could expect to paſs for a Man of Senſe and Underſtanding, if having found this Watch in a ſolitary Place, he ſhould pretend to believe that it was not made by a skilful Workman, nor that its Parts were put together with Judgment; but that there was a certain ignorant, and yet neceſſary Law of Nature prevailing in the World, that had brought into a regular Method all the Parts, of which this Watch conſiſted, and had adapted each of them to the Uſe of ſhewing the Time of the Day; and eſpecially that ſuch a Law of Nature was not only ignorant and unſenſible of all that it did, or brought to paſs, but likewiſe, that no Being, endued with any Wiſdom or Underſtanding, had eſtabliſhed and produced this Law at the Beginning, or in the leaſt contributed to the making the ſeveral Parts that compoſed a Machine proper to ſhew the Hours.

What has been ſaid above concerning a *Watch*, is not leſs applicable to all other artificial Works; it will be therefore unneceſſary to alledge any farther Examples of *Mills*, *Ships*, *Sluices*, *Houſes*, *Paintings*, &c. In all which, the Wiſdom and Underſtanding of the Maker does equally appear.

Finally, We may apply all that has been ſaid above to demonſtrate, that there is ſuch a Wiſe, Mighty, and Merciful Being as GOD, in caſe we can make appear with as great (not to ſay a much greater) Certainty and Conviction, from the Conſtruction of the viſible World, and all that paſſes therein, that there is a GOD and Great Creator, who in Wiſdom has made them all; as we can ſhew from the Structure of a Watch, and the Uſes that reſult from the ſame, that it has been made and put together by a judicious and skilful Workman; and this we doubt not of doing in the following Contemplations, with all neceſſary Clearneſs.

SECT.

SECT. XXX. *A particular Manner of Corroborating theſe Proofs in ſome other Circumſtances.*

WE ſhall not here ennumerate other Kinds of Proofs, to ſhew the Defect of the Principles of theſe miſerable Cavillers, which we have made uſe of upon ſome particular Occaſions in this following Work, becauſe we will not make this *Preface* too long. They that find them in ſome Places are deſired to apply them to others where they think them to be of equal Force; tho', for Brevity ſake, we may have there omitted them.

As for Inſtance, in caſe the Reader be not ſufficiently affected or convinced by what is ſaid of Living Creatures, Plants, Heavenly Bodies, and ſuch like, let him imagine to himſelf that he ſaw the ſame Things imitated in little; and that tho' they be incomparably more imperfect, yet they do in ſome manner counterfeit the Works of Nature. To ſpeak more plainly, let him fancy that he ſees a Wooden-Horſe put into a Motion by Springs and Wheels, a Wooden-Bird flying (of which Hiſtory has made mention) or let him ſuppoſe that he ſees in a little Machine, a gilded Globe, repreſenting the Sun, and other little Balls, which like Planets circulate about it; and then let him ask himſelf, whether he has Boldneſs enough to maintain, in the Preſence of Wiſe and Learned Men, that all theſe Things appear to him to be produced by *meer Chance*, or by certain *unknowing natural Laws*? And whether he has not a great deal of Reaſon to believe, that ſuch Sentiments would be juſtly laughed at, even by the Ignorant themſelves? And after all, let him conſider with how much leſs Reaſon he entertains ſuch Opinions, entirely different from thoſe of all wiſe Men, concerning the true, natural, and unconceivably

conceivably more perfect Things, which daily occur to his own, and all other Mens Obſervation in the World.

Sect. XXXI. *A General Proof, that the Scriptures are of a Divine Original.*

The ſecond Thing that is here neceſſary to be enquired into, before we paſs on to the *Contemplations of the World*, is a certain Manner of proving (which we ſhall upon ſome Occaſions hereafter inſiſt on) that the *Bible*, as it is call'd by *Chriſtians*, was writ by a certain Great and more than Humane Wiſdom, and that it is of Divine Authority and Original.

To ſpeak a Word or two of it here in general, I entreat my Reader ſeriouſly and carefully to conſider,

In caſe he ſhould meet with a Book, which for weighty Reaſons was held to be Divine by other People, among whom there were a great many that he allowed to be very underſtanding Perſons; and ſuppoſing, that whilſt he read and examined it, he ſhould find,

Firſt, That this Book did frequently make Mention of certain Qualities of Natural Things (tho' with another View, and as it were *en paſſant*) after ſuch a Manner, as none but an Eminent, Wiſe, and Experienced Naturaliſt could do; Whether he would not be obliged to conclude, with reſpect to that only, that ſuch a Book muſt have been writ with ſingular Wiſdom?

Secondly, Suppoſe he ſhould be farther convinc'd, by irrefragable Proofs, that this Book did repreſent, with the cleareſt Words, certain Properties of Natural Things; which at the ſame Time it was writ (at leaſt ſo far as can appear to us) were not known to any living Perſon, nor for

want of the neceſſary Inſtruments could poſſibly be known to any, whether it were to be doubted, that ſuch a Book were writ with more than Humane Wiſdom?

And this being granted, from whom can we more reaſonably conceive it to be derived, than from the Omniſcient Creator of all Things? To whom alone, the Things that were hid from every one elſe in thoſe Ages, were known and open.

And in caſe you deſire to have this laſt proved more ſtrongly, we may ſubjoin, *Thirdly*, That in ſome Places of this Book, is expreſs mention made of the Bounds and Limits of Humane Knowledge in future Things; the Truth of which could not appear, but to the following Generations.

This being ſo, as it ſhall be proved hereafter, Can any but a Divine Power determine and limit, by clear and plain Expreſſions, that certain Things ſhall come to paſs after many Ages? And when they have ſo happened, muſt not every one acknowledge, that it could proceed from no other than a Divine Original?

SECT. XXXII. *No Proofs can be brought of the Divinity of the* Alcoran *of the* Mahometans.

WHAT has been here ſaid concerning the wonderful Wiſdom, that ſo brightly appears in the Holy Scriptures, might truly be urged upon many Occaſions againſt the *Alcoran* of the *Mahometans*, where we ſhould in vain ſeek for an Account of the Conſtruction of the World, of which ſo much appears in the Bible of the *Chriſtians*; but ſince theſe Papers are not ſo much calculated for the Conviction of *Mahometans* as of *Atheiſts* and *Unbelievers* in general, it ſeems to me ſufficient juſt to touch

touch upon it here, without repeating it upon every Occaſion in the following Diſcourſes.

SECT. XXXIII. *A ſhort Account of what is propoſed to be done in the following Work.*

NOW that we may reduce all that has been ſaid to it's *End* and *Deſign*, and that we may convince every reaſonable Perſon of the Perfections of GOD, this alone chiefly remains;

Firſt, That we endeavour to ſhew, that in the viſible World, or rather in that little of it that is as yet thorowly known to us by Experience, there does appear ſo much Wiſdom, ſo much Power, ſo much Goodneſs and wonderful Views, that the greateſt Work of Art that ever was prepared by Men, is not comparable to it in the leaſt.

And, *ſecondly*, that we endeavour by convincing Examples, to ſhow the undeniable Truth of what has been ſaid above, relating to the Holy Scriptures.

We know very well that an *Atheiſt* may, upon ſome Occaſions, object againſt this laſt; that, *perhaps*, at the Time when the *Bible* was writ, *Teleſcopes* and *Microſcopes* were in uſe, and, *poſſibly*, brought to as great, if not greater Perfection than we find them in this preſent Age; by which Means they will endeavour to evade the Proof which we, in ſome Places, have urged from the late Diſcoveries thereof: But to anſwer them in one Word, let them conſider with themſelves,

Firſt, That altho' we have Aſtronomical Obſervations of many Ages paſt, and with them the Deſcriptions of ſeveral Inſtruments then uſed; yet we do not find any mention made of *Teleſcopes*,

nor ſo much as the Name of *Microſcopes* among any of the ancient Enquirers into Nature.

Secondly, That the Inventors of theſe two Inſtruments, who lived in the foregoing Age, were known to all the Philoſophers; no body being yet able to prove from any Memorials, that they were known to others before.

Thirdly, Whether it be credible, that the old *Aſtronomers* or *Naturaliſts*, if they had known the Things that have been ſince diſcover'd by their *Optical* Inſtruments, would have tranſmitted down to Poſterity their defective, and, many times, falſe Conceptions of Things.

Finally, And which is of the greateſt Importance, let them ſeriouſly conſider, how prudent it is, in a Matter upon which their everlaſting Welfare or Miſery depends, to ſupport their Sentiments with a *perhaps*, *or it may be*, when, beſides, every Thing that appears in Hiſtory makes againſt 'em.

The Chriſtian Philoſopher:

OR, THE

Right Uſe of the Contemplation

OF THE

WORLD,

FOR THE

Conviction of Atheiſts and Infidels.

CONTEMPLATION I.

Of the Vanity of all Worldly Things.

SECT. I. *Every Man is placed here without his own Concurrence.*

TO begin therefore by convincing not only thoſe who are ſtill under Doubts, (whether they be to be reckoned among the External Chriſtians or not) but even the deplorable and obſtinate Atheiſt, of the great Neceſſity there is to be rightly aſſured of the moſt important Truths, and to correct thoſe Miſtakes which he has

hitherto admitted concerning every one of 'em; is entreated moſt ſeriouſly to reflect upon the Things which his own Experience informs him daily to come to paſs about him, and to ask his own Conſcience, whether he don't find himſelf placed in this World without any Act or Concurrence on his own Part? Whether it be in his Power to prevent his being one while Happy, Healthy and Strong; another while Unhappy, Sick and in Pain? Whether one Day does not follow another without his Leave, in which divers things befal him, ſome with, others againſt his Mind, notwithſtanding that he feels in himſelf a continual Deſire influencing and governing all his Endeavours of obtaining Good, and avoiding Evil; which ſometimes ſucceeds, and at other times happens quite otherwiſe than he hoped for or intended, by Accidents which he could not eſcape?

Whether he does not obſerve, that what befals him is in common with other Men? But chiefly, Whether he does not ſee that many Men die daily, and that very few of them ſeem to have any Thoughts concerning Death, eſpecially whilſt they are in Health? Notwithſtanding that Sickneſſes and Diſeaſes, by which they are ſnatched away, oftentimes ſtand in need of but few Weeks, ſometimes few Days, yea even Hours, to change them from ſtrong and healthy Men into dead Bodies or Carcaſſes.

Sect. II. *And muſt be convinced of the Uncertainty of his Life.*

Further, whether he is not like all other Men, ignorant of the Time when Death ſhall overtake him? Yea, at the End of one Year he ſees a great many, who, in the Beginning of the ſame, were alive and healthy (and ſome of whom ſeemed

to

to be ſtronger than himſelf) to be ſingled, as it were with Deſign, out of the great Number of Mankind, and to be a Sacrifice to Death and the Grave; and that no Body has been able hitherto to find out any Rule or Law whereby he could conclude, that this or that Man ſhould die firſt; unleſs perhaps ſome very old or incurable Perſons, of whom indeed he might ſay, that their Death was not far off: But even in ſuch caſe, 'tis not leſs true that he is ignorant, as near as they may ſeem to be to their End, whether he himſelf ſhall not go before them; ſo that every Man is forced to own, that his End may be near, as well as that of thoſe whom he ſees die before him; and who, whilſt they were in Health, knew as little thereof as he himſelf does now of his own Death.

SECT. III. *He muſt likewiſe be convinced of the Vanity of all worldly Things with reſpect to himſelf.*

NOW ſince Death does ſo ſurely overtake every Man, and yet the Time of it is ſo uncertain; ſince it deprives us of the Uſe and Enjoyment of all that is in the World, ought not every one that conſiders theſe Matters be convinced of the great Vanity that is in himſelf, and in all worldly Things with reſpect to him? Foraſmuch as he cannot enjoy either Profit or Pleaſure from thence, but ſo long as he lives; and how long, or how ſhort that Life will laſt, he knows not. This only he knows, that when he is arrived to a certain Number of Years, it cannot be very long: And he cannot ſay, if he conſiders every thing as he ought, that it is very deſirable to attain to a great Age; ſince being deprived of the Uſe of all his Faculties, his Death is as it were anticipated thereby; for it leaves him neither Feet to walk, Eyes to ſee, Ears to hear, or Teeth to eat with;

and thus, while he is ſtill alive, he is by degrees thruſt out of the Company of Men, and becomes, as one may ſay, a living Carcaſs.

SECT. IV. *It is not even deſirable to live here continually, tho' in Health.*

NOw if we ſhould add to all this, that ſuch as live long are not only ſubject to the Infirmities of old Age, but often to very grievous Sickneſs and Pains; ſome of which are entirely or almoſt incurable, *viz.* in caſe he be deprived of all his Strength, and worn away by a Conſumption, or tormented by the Gout, or Stone in the Bladder, by a cancerous Humour, or by the Falling Sickneſs; to ſay nothing of a thouſand other Diſtempers, to which he is obnoxious, and which he may juſtly apprehend, becauſe he ſees ſo many other Men affected with 'em: Would not he have a great deal of Reaſon to wiſh that merciful Death might ſet him free from all theſe, and from miſerable old Age at the ſame Time?

Now if one ſhould ſuppoſe, which however ſcarce happens to any Man, that the Evils of old Age do not render his Life a Burden, and that he ſhall enjoy even as long as the World it ſelf ſhall laſt, the ſame Strength both of Body and Mind as he did in his Youth; yet when he ſeriouſly conſiders every thing, this very State and Condition far from being deſirable, muſt appear to him very deplorable: For, *Firſt*, In caſe his Native Country ſhould be ruined and laid waſte by Earthquakes, Inundations, or War, he cannot eſcape Miſery and Poverty as well as the reſt: And how many Years of tedious Labour are there required to repair what he has loſt, ſo as to be able to enjoy the ſame the remaining Part of his Life? And having ſcraped it up again with Trou-

ble,

ble, muſt not this Man, who is to live as long as the World ſtands, be always in Pain and Fear of loſing it, either after the ſame, or ſome other Manner? At leaſt ſince the World it ſelf is ſubject to thoſe Revolutions with which the Hiſtories, of all Ages have acquainted us. How few Governments are there that have been able to keep their Footing for ſeveral Ages together, and of which the Inhabitants have not been driven or rooted out? And on the contrary, how many can we reckon, which after they have riſen to the higheſt degree of Glory and Grandeur, yet at laſt have found their End in an entire Deſtruction? So that even ſuch a long and healthy Life, as we have been ſuppoſing, would only be a miſerable Pilgrimage for him, in which, when he had hardly come out of one calamitous State, he would be in a continual Apprehenſion of another.

And if no evil Accident ſhould overtake him (which is not to be conceived) what Pleaſures are there in the World that are laſting? So that he can expect nothing elſe but that ſuch a Pleaſure, which whilſt it was new, was very agreeable to him, either by long Enjoyment (as Cuſtom renders all things) would become firſt indifferent, and afterwards inſipid; or at beſt, by the Uncertainty which is viſible in all Things, would ſoon forſake him: Had he a Wife, Children, and good Friends, which are the moſt comfortable things of this World, they would all die before him; and he would every time be ſubject to that Heart-breaking Sorrow of loſing thoſe deareſt Treaſures were they to live long? So ſoon as they are overtaken by the Infirmities of old Age, they would only be continual Objects of Pity, and conſequently of Grief to him: Yea, every Thirty, Forty, or at leaſt Fifty Years, he would meet with a new

a new, and conſequently a ſtrange Generation, and be obliged at every Turn to enter into new Friendſhips and a new Acquaintance; or to converſe with unknown People, whoſe Inclinations he muſt ſtudy and learn to know again, to the End that he may, whether he will or no, conform his own to theirs, if he expects to enjoy any Favour or Kindneſs among them, and not to be excluded from their Converſation as a ſtiff and unnatur'd Fellow: And if he has had Children, of which even a numerous Poſterity are remaining, what Friendſhip and Love can he promiſe himſelf from them? Who, tho' they were deſcended from him, would be yet in a remote Degree of Relation; ſince Experience teaches us, how ſoon all Kindred, after a few Deſcents, grow ſtrange to one another: And I have often thought, if *Adam* himſelf, our common Father, ſhould return again to the World, and ſtay here ſome Ages, whether any of his Poſterity would receive him friendly? Eſpecially if he ſhould pretend to make uſe of that Right, by which he alone would be entitled to, the Property and Government of every thing: Would not the moſt Part, if not every individual Man, think that he did them Wrong, and ſee him, with concern, taking Poſſeſſion of their Habitations? Now in caſe the Reſpect and Love which every one owes him, could not ſo far prevail, as to render a Father happy among his Poſterity, what could be expected by a Man in ſo great, tho' ſtrong and healthy old Age, who would be no longer conſidered as a Father, but as a remote Kinſman, whoſe Pedigree could not be traced, or perhaps even as a meer Stranger?

Sect. V. *The miserable Condition of the Atheist.*

Since then a long and healthy Life, which otherwise seems to be the most desirable Blessing upon Earth, is so vain, a Man cannot be render'd happy thereby; let any one who doubts or denies the Perfections of a God, extend his Thoughts farther; and see, *First*, How dreadful such a Life would be to him in particular, even tho' according to his miserable Philosophy, he had no God to fear, and that all Things were directed either by meer Chance, or by irrational, unknowing, and necessary Causes.

For from such Principles as these, he must grant, that in case he were unhappy, nothing but Chance could relieve him; if he were happy, since the Cause thereof is accidental and ignorant of its own Effects, he must live in a continual Fear, that every Moment may change his Condition: And not to reckon up all the Circumstances that may evince the same, what is there in the World from which he can expect the least Happiness or Advantage with any Foundation of a reasonable Hope, and from whence he can expect any Love or Good-will towards him, let him behave himself as he will? And that Man's Life must be very Miserable, who is neither Loved nor Esteemed by any Body. Suppose he were a Prince that Governs a whole Nation, how can he think, without great Uneasiness, that it is by meer Chance his Subjects obey him? If he be subject, and lives under the Command of a Superior; must he not tremble when he considers that it is Accidental only that his Goods are not stolen; his Houses burnt; his Wife and Daughters Ravished; his Sons carried into Slavery or Murdered; and that it is by meer Accident that his Children

Children, being Wicked, do not, without any ſcruple of Conſcience, Poiſon him for the Sake of his Inheritance, in caſe they think he keeps them too long out of it? And ſince upon this ſame Hypotheſis there is no kind of Order or Providence, and that Chance, as Chance, may at all times produce, indifferently, this or that Effect; Muſt he not tremble when he looks upon the Earth, which, if every Thing depends upon Chance, may immediately begin to burn under him, or may open her Mouth and ſwallow him up? And if he looks into the Air, muſt he not imagine, that it is purely Accidental that he is not deſtroyed by Storms and Tempeſts, by Thunder and Lightning, or that Rains and unſeaſonable Weather do not ruin all his Plantations and Poſſeſſions?

In vain, alſo, will he endeavour with ſuch like Conceits to avoid all theſe Terrors; tho' he ſhould admit that it was not a meer Chance, but an unintelligent Neceſſity which Governs the Univerſe by certain unchangeable Laws; for ſince according to theſe ſuppoſed Laws, he ſees ſeveral interfering Operations of Nature come to paſs, whilſt he ſees the Air one time Calm, another time Tempeſtuous; whilſt he ſees the Wind from the South, and then again from the North; the Sea Ebbing and Flowing; one Seaſon extreamly Hot, another very Cold, and the like; muſt he not confeſs (tho' he ſhould ſuppoſe that all this did neceſſarily happen) that it will be as terrible to him as Chance it ſelf; to him who knows not when a contrary Effect ſhall be produced according to theſe ſame Laws.

SECT. VI. *The Advantages which they that Love and Fear a God enjoy.*

LASTLY, let him tell us ſincerely, whether in reſpect to all that has been ſaid, he does not think thoſe Perſons to be unſpeakably more happy, who are convinced that they depend upon an adorable Creator; by whoſe Wiſdom they have been ſo wonderfully formed; whoſe Power has render'd ſo many of his Creatures ſubſervient to their Well-being; who has given them the Capacity to enjoy the ſame with Pleaſure and Thankfulneſs; who being Wiſe and Mighty can preſerve them, and being Merciful will preſerve them; that without his good Pleaſure, none of the aforeſaid Evils come upon them; inſomuch, that if He be with them, nothing can be againſt them; who, beſides, the good Things of Nature which He is largely and conſtantly dealing out to them, makes known his Word to them; and to remove all their Doubts, has ſtamp'd it with irrefragable Marks of its Divine Original; who has there revealed His Will, purſuant to which He will be ſought after, ſerved, thanked, and praiſed by them; who has there manifeſted his Love to them which paſſes all Underſtanding; and has likewiſe promiſed to render them eternally happy after Death.

SECT. VII. *It is therefore neceſſary to ſeek for the Demonſtrations of a God,* Pſalm xiv. 1.

NOW ſince every Atheiſt muſt confeſs, that his own Principles (unleſs he will deny them too) do render him unhappy, and cauſe him to live in continual Apprehenſions; I leave him to judge, whether a Man muſt not be a very abſurd Perſon, and,

and, as it were, an Enemy to himſelf, who notwithſtanding that he ſees the contrary Opinion maintain'd by many others, of whoſe Wiſdom he has no Reaſon to doubt, yet takes all the Pains imaginable to perſwade himſelf that there is no GOD; and therefore, whether the *Holy Penman* of the firſt Verſe of the 14th *Pſalm*, has not a great deal of Reaſon to give ſuch a Man the Name of *Fool?* Who tho' he can never prove his Opinion, yet with all his Heart, and all his Soul, endeavours to make himſelf Miſerable, and to run headlong into a State full of Terror and Diſtraction; that is to ſay, into the Condition of an *Atheiſt*.

For a Confirmation of the Truth of what has been here ſaid, I could farther add, that I my ſelf have heard one of theſe miſerable Wretches, whoſe Judgment ſeemed capable of every Thing but acknowledging a GOD, lament the Unhappineſs of his Condition with great frankneſs, and in the moſt pathetick Manner.

And I can't forbear ſaying, that the Remembrance of it does ſtill very much affect me whilſt I am now writing it, tho' long after his Deceaſe.

To proceed; If any one has a true Love for himſelf, and does but hear that it is maintained by many Perſons for an uncontroverted Truth, that there is a *Wiſe*, *Mighty*, and *Merciful* Creator of the Univerſe, who can render all thoſe that endeavour to know, ſerve, and honour Him, Happy, both now and for ever; and thoſe that deny or deſpiſe Him, Miſerable to all Eternity: I ſay, that Man muſt be in a very deſperate Mind, if he does not think it to be of the utmoſt Importance to enquire into the Force of ſuch a Proof, upon which ſo many wiſe Men, living and dying, do entirely depend.

SECT.

SECT. VIII. *The Tranſition to the following Contemplations.*

I HOPE then, that among theſe unhappy Men there may be ſome found, who, in order to free themſelves from theſe ſad Uncertainties (for no *Atheiſt* ever had any Certainty of his wretched Notions) will think it worth their Pains, ſeriouſly to weigh the Arguments that may contribute thereto; and we beſeech ſuch to paſs on along with us to the following Contemplations; and perhaps the Great God of Heaven and Earth may vouchſafe (as we heartily beg of Him for their Sakes) to open their Eyes, to the End that they may ſee, and be fully convinced of the unexpreſſibly amiable Perfections of his glorious Works.

CONTEMPLATION II.

Of all that is Viſible, and of Our ſelves in particular.

SECT. I. *It is neceſſary to call upon GOD at the Beginning.*

BEfore we come to the Thing it ſelf, and from the viſible Part of the World endeavour to ſhew, that in the Structure thereof, the Wiſdom, Power and Goodneſs of the Great Creator ſhines out with more Brightneſs and Luſtre, than to admit of a Compariſon between any of his Works, and thoſe of the moſt skilful Artificer that

that ever was. Let it not seem strange to any one, that in this Enquiry, which perhaps may be thought purely Natural, we affirm it to be absolutely necessary, first of all to implore the Great Creator and Governor of all Things, with the deepest Humility, that He would be pleased to enlighten our Understanding (which in it self is so dim) that we may view and comprehend the Beauties and Wonders of his Works; and farther, that thro' his Goodness He would vouchsafe to purify our Hearts from all contradicting Passions and unreasonable Notions resulting from thence; since it is not unknown to any one who has obtained this Grace, that He can, as it were, feel and discover, in innumerable Things, with an entire Conviction of his Conscience, the adorable Maker of them; that many Things have often presented themselves to his Mind formerly, and have been rightly understood and comprehended by him, without once exciting him to look up to the first and chief Cause thereof: So that it plainly appears from hence, that neither the Penetration of his Judgment, nor the Things themselves, are sufficient to lead him to a right Contemplation, without some farther Assistance besides them. And in case an Atheist should only consider these Convictions as Historical Truths; yet at least he must acknowledge, that in a Matter of so great Importance, and upon which his everlasting Happiness or Misery depends; it would do him no Harm, according to his own Principles, if, like the *Athenians*, he should invoke the Assistance of a *GOD*, as yet *unknown* to him.

Sect. II. *GOD's Eternal Exiſtence proved from the Creatures.*

Now to proceed to our intended Work: Since our Deſign is rather to Offer or Propoſe the Proofs of the Perfections of God, that is to ſay, of his *Wiſdom*, *Power*, and *Goodneſs*, by way of Conviction to unhappy *Atheiſts*, and doubting Minds, than to prove his *Eternal Exiſtence*, that being not denied by any *Atheiſts* who own an *Eternal Being*, as far as I know; yet if there be any among them ſo blind as ſtill to doubt, whether this alſo can be demonſtrated from his Works, we ſhall likewiſe endeavour to give them full Satisfaction herein, and to produce unanſwerable Proofs thereof in this very Place, before we proceed to the other.

Let the *Atheiſt* then ask himſelf, upon the Suppoſition that there was no Eternal Being, that is, in caſe there ever was a compleat *Nothing*, when there was neither Creator nor Creature, nor any thing whatever that had an Exiſtence, whether he muſt not be convinced, that in all Eternity the ſmalleſt Thing whatever could not come to Exiſt; and that ſuch a *Nothing* muſt remain and continue to infinite Ages a meer and ſimple *Nothing?*

So that not only from theſe vaſtly extended Heavens, and their unſpeakable great Lights and Bodies, but even from the moſt tender Leaf or Graſs, from the moſt contemptible Stone we tread upon, and from the ſmalleſt Grain of Sand, this Aſſertion can be irrefragably maintained, ſince if ever there was a compleat *Nothing*, the very meaneſt of all theſe could never have been produced, or made to Exiſt in an Infinity of Ages.

SECT. III. *The ſame proved from* Romans i. 20.

AFTER the ſame Manner we ſee the Apoſtle *Paul* proving God's *Eternal Power*, whereby He Exiſts of himſelf from all Ages, and his *Divinity*, whereby He is diſtinguiſhed from all Creatures that have had a Beginning; and thus ſpeaking in his Epiſtle to the *Romans*, *Ch.* i. *v.* 20. *The inviſible Things of him from the Creation of the World are clearly ſeen, being underſtood by the Things that are made, even his Eternal Power and Godhead; ſo that they are without Excuſe:* And ſhewing likewiſe that in naming the Creatures in general, he excepts nothing out of 'em, how ſmall ſoever it may be, which by its Exiſtence is not capable of convincing, with the utmoſt Certainty, every one that has not quite loſt the Uſe of his Reaſon, of GOD's *Eternal Power and Divinity*, that is, among other Things, of his *Eternal Exiſtence*.

SECT. IV. *The Contemplation of Ourſelves in general.*

NOW as this Contemplation of all Creatures in general, after the aforeſaid Manner, is a Teſtimony to every Man's Conſcience, that there is an Eternal GOD; ſo likewiſe will every Man that only views the Frame and Conſtruction of himſelf, (and conſiders who he is, and whereof he conſiſts; how he is come into this World and ſupported therein,) from thence be convinced of the Wiſdom, Power, and Goodneſs of ſuch a GOD, without hardly conſidering any other Particulars, tho' we hope alſo to Account for them hereafter.

He, therefore, who has hitherto denied or doubted of ſo weighty a Truth, let him turn his Eyes and Thoughts firſt upon himſelf only, when

when he cannot but confeſs, that he has a Body, of which, being in Health, he is capable to move ſome Parts, ſuch as the Hands, Feet, Eyes, *&c.* arbitrarily, and according to his own Pleaſure; and again (which is very remarkable) that his Will has little or no Influence or Power over other Parts; thus his Heart beats, his Blood circulates, his Stomach and Bowels are moved; the Humours and Fluids, which compoſe ſo great a Part of his Body, produce ſeveral Effects in him, without his being able either immediately to hinder or promote their Operation: Moreover, he finds that he Underſtands, Wills, Reaſons, Loves, Hates, Fears, Hopes, and (in one Word, that Philoſophers commonly make uſe of to Sum up the whole) that he *Thinks*.

Sect. V. *The Contemplation of our Body, which is Earth.*

Now upon enquiring firſt into our Body, we are convinced by certain Experience, that the ſame conſiſts of the Food we uſe, ſuch as Herbs, Fruits, Corn, Fleſh, Fiſh, Water, and the like. The Beaſts have likewiſe their Food; and tho' theſe eat one another, yet the Food of moſt of them conſiſts of Plants and Water; for as for Foſſils, Metals, and ſuch like, we do not yet know that they ſerve for Food to any Creatures; and tho' they ſhould, yet the following Proof will remain in its full Force.

Now all theſe Plants ſpring out of the Earth, and being ſown, ſeem to draw their whole Subſtance from Earth and Water, excepting only what Air, Light, or ſuch like Matter, may contribute thereto; which Mixture of all together, becauſe we meet with it in all fruitful Soils, we ſhall hereafter, for brevity ſake, call by the common Name of Earth.

From whence then a Man muſt finally conclude, that the Matter whereof his Body conſiſts, is nothing but the Water he uſes in his Drink, together with an alter'd and diſguiſed Earth, which firſt becomes Plants, and afterwards is turned into the Subſtance of his Body.

Now if all this does not appear clearly enough to him, let him ſuppoſe the Perſon of a Man, who having been before very Fat and Heavy, has loſt ſome Pounds of Fat by Sickneſs; if ſuch a Man being reſtored to his Health, and uſing no other Food than Bread and Water, ſhould again attain to his firſt Weight, whence proceeds this his new Fleſh, but from the aforeſaid Bread and Water? but more eſpecially, if he conſiders the Smallneſs of his Body in the very beginning, which when his Mother firſt conceived him, was ſcarce of the Weight of half an Ounce, tho' the ſame Body afterwards, firſt by the Nouriſhment it received from the Mother, and afterwards what it took in it ſelf (both which, with reſpect to the Matter of it, can be called nothing but Earth) grows up to a Man of ſo many Pounds weight; and will he then ſtill doubt, ſince all this Nouriſhment conſiſts of Water and Earth only, whether his whole Body, in its utmoſt extent, is any thing elſe but a Metamorphoſed Earth?

Sect. VI. *That the Body does not Think.*

Having now diſcover'd theſe Things concerning his Body (that we may advance a little farther) let him ſuppoſe himſelf ſitting with another Perſon at Dinner, could he think that the Bread, Fleſh, Fiſh, Beer, Wine, *&c.* that are eaten and drunk, ſhould firſt become Nouriſh-

ment,

ment, and afterwards being turned into his Body; (or rather, that a quantity of Earth, from whence this Nouriſhment proceeds) has the Capacity to judge of, and to underſtand his, or another Man's Diſcourſe; or can comprehend the Demonſtration of a Propoſition in *Euclid?* or let him conſider, whether a skilful Chymiſt and Philoſopher could ever juſtly fancy to himſelf, that he was able to produce, out of ſuch Food or Nouriſhment, a ſolid or fluid Body (beſides which two, no third can be ſhewn) that can Think, Reaſon, and Diſcourſe like a Man? Now I cannot bring my ſelf to ſuch a Belief, that there ever was any Man, who deſired to paſs for a Perſon of the leaſt Senſe, capable of advancing ſuch Notions, and intrenching himſelf in the ſame, againſt an approaching Eternity.

Sect. VII. *The Soul demonſtrated.*

All this being duly weighed, can a Man make any other ſort of Concluſion, than that his Food conſiſting of Earth and Water is the Subſtance of his Body; and that nothing of thoſe, or of any thing elſe produced by thoſe, (nor conſequently his Body) is capable of *Underſtanding*, *Reaſoning*, or *Thinking*.

And yet he is aſſured, and plainly convinced, that he both *Underſtands*, *Reaſons*, and *Thinks*; this therefore is an irrefragable Proof that there is ſomething elſe in him beſides his Body, which *Underſtands*, *Reaſons* and *Thinks*; ſo that he does thereby know ſo much of himſelf, as that he is compoſed of two diſtinct Subſtances, *viz.* of a Body which is Earth, and of ſome other Thing beſides his Body, which other Thing *Underſtands*, *Reaſons*, and *Thinks*: This laſt is called the *Soul*;

and therefore he knows that he does conſiſt of a *Body* and *Soul.*

SECT. VIII. *No Man proceeds from himſelf, nor from his Parents, but from another.*

BEING come thus far, and knowing what he is, let a *Sceptick*, or an *Atheiſt*, go a little farther with us, and endeavour to find out how he came into this World, and how he is here ſupported.

And that he may bring himſelf to conſider the ſame experimentally, let him examine himſelf, and ſee, if it was in his Choice or Power to be here or not; whether he would chooſe to be formed Sick or Healthy, Blind or Seeing, Streight or Crooked: To all which, without doubt, he will anſwer, that he would rather be form'd with the good Qualities. On the contrary, let him by his own Experience enquire, whether he be not placed here without the leaſt Act or Concurrence of himſelf, and entirely without his own Knowledge in the Condition wherein he finds himſelf, and wholly uncapable of beſtowing on himſelf more or fewer Advantages of Nature: Conſequently then, he muſt be convinced that he does not proceed from himſelf, but from another.

But ſuppoſing it ſhould be objected by ſome body (who being wavering and full of Doubts, and unwilling to conſent to what has been here advanced, leaſt he ſhould be forced to acknowledge a GOD) that his Parents were, by way of Procreation, the firſt Cauſes of his Exiſtence in this World; which at firſt ſight carries ſomething ſpecious with it. Yet if he will be pleaſed to penetrate farther into the Matter, he cannot refuſe believing, that his Parents, as well as others, owe their beginning to that deſire of propagating their

their Species, which is naturally implanted in all Creatures; without any Certainty at the ſame time, or thought of the Conſequences of ſuch an Act: And muſt he not, moreover, confeſs, that none of 'em all were capable of knowing or ſaying whether it ſhould be a Man or Woman, a deformed or well-ſhaped Child that was to be produced? Yea, after the Birth, does it clearly appear to either of the Parents, how the Body of ſuch a Child is framed with reſpect to its Veins, Nerves, Fleſh, Bones, Humours, and other Parts?

Now if all this be brought to paſs without the Knowledge of the Parents; if they be entire-ignorant of the Compoſition or Structure of their Child, how can he look upon them as the true Cauſe of his Being and Subſiſting? Can one juſtly hold that Perſon for the Artificer, or the real Cauſe of any Machine, who is forced to own that he does not know any thing of the Conſtruction, nor how it came to be ſo made? and yet more, who did not ſo much as know even whether it was made by him, tho' he did all that lay in his Power towards the Production of it?

And ſince he cannot judge that his Parents have contributed more to him than others do to their Children, muſt he not own that it follows from thence, that he is placed here entirely without his own Concurrence, and without being able to prove that his Parents are any thing elſe but unknowing, and conſequently no true, but at the moſt, inſtrumental Cauſes only of his Exiſtence?

Moreover, to the end that we may obviate all Evaſions, and demonſtrate undeniably that he cannot be produced by his Parents as true Cauſes, let him recollect, that beſides his Body there is a Soul of which he conſiſts, which has been already ſhewn to be entirely different from his Body: Now all that could happen towards his

Production on the part of his Parents, seems only to have respect to his Body, and consists in nothing more than in the Communication of the *Semen Corporeum*, which likewise has its Original from Food and Nourishment; and therefore, according to what has been proved above, is nothing else but Metamorphosed Earth and Water. Now this Earth and Water, or any thing else that proceeds from them, does neither Understand nor Think, and yet he himself does both; for which Reason he ought certainly to be convinced, that he, as a Man, that is to say, as an Intelligent, Rational, and Thinking Creature, can by no means owe his Being to his Parents; and since he cannot be the Cause of himself neither, he must therefore, as well as all his Forefathers, have been brought into the World by some other Being.

I have here in the Beginning, that I might not seem to argue too acutely, passed over those Modern Observations, by which it is pretended, that the Humane Body draws its Origin from a *Stamen*, or Fundamental Principle, in which the Members are rolled up as in a Clew or Ball of Thread; which afterwards, by the Help of Nourishment, is filled up and unfolded to a Visible Body. The Reason is, because the Proof which we have here in View would still remain of the the same Force. *First*, Since this *Stamen*, how small soever it may be, whilst it continues unfolded, is nevertheless a real Corporeal Substance. *Secondly*, Because it is not yet proved, that this *Stamen* does not proceed from the Fluids of the Father or Mother, or of both, and therefore does likewise consist of disguised Earth. *Thirdly*, By what Cause soever this *Stamen* is produced, it cannot be denied, that when it is quite unfolded into a Visible Body, it is nevertheless a Corporeal Sub-

Substance, and so remains. Now that such a Substance can Discourse or Think, no Body that would pass for a Wise Man will rashly affirm; nor do I believe neither, that there was ever any one found who would persist in this Notion, That we ought to ascribe the true and real Cause of the Formation of our own *Stamen*, or of any other Humane Body, to our own Knowledge, or to that of our Parents: Whoever, therefore, does any Thing ignorantly and unknowingly, cannot, as we have said before, be consider'd any otherwise than as the Instrumental, but by no Means the true Cause of any Effect; from whence it follows, That the Conclusion must remain as it did; namely, that neither our Parents, nor we our selves, are the true Causes of our Existing here.

Sect. IX. *That our Support is from Another.*

Now after the above-mention'd Discoveries, it may easily be made appear to every Man, that as he is not placed here by his own Power, so neither is he supported by the same: For if he were, he might at least provide Food and Nourishment for himself; but can he make the Sun to Rise, which causes every Thing to spring out of the Earth? Can he bring down a Drop of Rain from Heaven, which renders the Ground so Fruitful, and which likewise must serve him for Drink? Can he communicate an Existence, and the necessary Properties to one single Ear of Corn, or to the smallest Blade of Grass, in order to feed himself, and those Creatures which he uses for his Nourishment? But to go yet farther, supposing he had Food in abundance, can he tell after what manner his Body is thereby supported? or does he know where that which refreshes his Body remains, as soon as it has passed thro' his Stomach and

and Bowels, and how his Food is turned into Blood and other Juices, and how they again are converted into ſuch different Parts, of which his Body conſiſts? So that here again he can conclude no otherwiſe, than that all this ſurpaſſes his Power, and that it is not by himſelf, but by ſome other Being, that he Exiſts and is Upholden.

SECT. X. *And this other Being, either knows, or is ignorant of what he doeth.*

Now being thus far aſſured from what has been ſaid, that a Man is not produced by himſelf nor by his Parents, but by ſome other Being, by which he is likewiſe ſupported; I leave any one to judge, whether he can live in a perfect Tranquility without endeavouring to know what kind of Being it is, by which he is Made and Supported; ſince I cannot think that he is ſo inſenſible, or ſo little affected concerning thoſe Things that relate to his own Happineſs or Miſery, as not to look upon this to be an Affair of the utmoſt Importance.

If then he will endeavour with us to enquire into theſe Matters, he muſt at leaſt acknowledge for an undeniable Truth, that the Cauſe by which he is here placed and ſupported, does either know and underſtand its own Actions, or elſe is entirely ignorant of them; that is, he muſt either agree with the wiſeſt part of the World, that there is a GOD by whom he is made and ſupported, who knows what he did, and what he daily does, with reſpect to him; or elſe he muſt endeavour to perſwade himſelf, purſuant to thoſe Principles of unhappy *Atheiſts* (which have never yet been demonſtrated) that he was brought into the World by a meer and ignorant Chance, or by a neceſſary Conſequence of the Laws of an unknowing

knowing Nature: One of these must be undoubtedly true.

Sect. XI. *That our Maker and Preserver is Wise, Mighty and Merciful.*

Now in order seriously, and without Passion or Prejudice, to consider so important a Matter, and to know which of these two Questions are to be received for Truth; let him suppose, that he were to be brought into a Room, where he should see several Clocks and Watches that have been adjusted with all the Skill and Perfection the Artificer could exert, so that they went very True and Regular; and then let him ask himself, whether he thinks those Machines could acquire their Existence and Aptness to perform their several Functions, without the Concurrence of the Skill and Judgment of a Workman, and only by Causes that were ignorant of the Effects they produced, such as meer Chance, or necessary Laws of Nature? and whether he would not judge that any Man, who should undertake to deduce such Conclusions from his own Philosophy were not quite out of his Senses?

After having maturely consider'd all this, let him proceed farther, and instead of Clocks, let him cast his Eyes upon the Frame and Construction of his own Body, or upon that of Beasts, Birds, Fishes, Plants, and other Wonders of Nature, and think, since a good Clock does undoubtedly prove its Workman skilful, whether in each of these last mentioned Things there does not appear an Art incomparably greater than that which shews it self in the very best Clocks? forasmuch as it is most certainly true, that the best Artificer in the whole World, is not capable of producing even a Mouse or a Fly, a little Flower

or

or a Plant, tho' never ſo ſmall, in ſuch a Perfection as we ſee them daily appearing. Let him therefore ſilently examine himſelf, whether all his Atheiſtical Arguments can bring him to embrace theſe miſerable Notions for Truth with Tranquility, and without a continual Remorſe of Conſcience, *viz.* that he who made his Body, and all theſe Things after ſo wonderful a Manner, and out of ſuch improper Matter as the Earth appears to be for ſuch a Purpoſe, ſhould be ſo far void of Wiſdom and Underſtanding, as not to know after what Manner, nor to what End, he had made the ſame?

Now ſince an unhappy *Atheiſt* ſeems to be unavoidably obliged by all theſe Things, to acknowledge that his Creator is wonderfully Wiſe; ſince, moreover, the Manner whereby he is preſerv'd, ſeems to convince him, that this his Preſerver is not only Wiſe, but alſo Mighty and Merciful; having moſt bountifully provided ſuch a great Body as the Sun to give him Light, the Air ſurrounding this whole Earth for Reſpiration, ſo great a quantity of Water to aſſwage his Thirſt, ſuch a number of Plants and living Creatures to ſatisfy his Hunger, and to refreſh him, and ſo many other Things for other Uſes, without any Co-operation on his Part, and ſuch wonderful Faculties for the Enjoyment of them all: Let him finally conſider with himſelf, what he ought to expect, even in his own Judgment, from the juſt Wrath of this his Maker and Preſerver, in caſe he continues to deny his Wiſdom, to deſpiſe his Power, and to be Ungrateful for his Mercies, and in order to free himſelf from the Obligations he lies under to Providence for all theſe good Things, if he continues to aſcribe them all entirely to inſenſible and ignorant Cauſes.

Sect. XII. *The Tranſition to the following Contemplations.*

I CAN ſcarce think it poſſible, that there ſhould ſtill be an *Atheiſt* ſo deplorably obdurate, after having weighed all theſe Things moſt ſeriouſly by himſelf, as to dare to own, that the Conſideration thereof does not make him uneaſie; and in caſe there ſhould be any that had ſo far abandon'd themſelves to their ſeducing Paſſions, yet it is not to be imagined, that all of 'em have ſo greatly renounced their Reaſon, as not to think it worth their While to paſs on with us to the Contemplation of the Works of the great Creator in the following Diſcourſes; or that among ſo many Particulars and Wonders, which they will there meet with, there ſhould not be one ſingle one ſufficient to make them ſee their Error, and to give them a convincing Proof of a Deity ſhining out ſo brightly from thence. This I can ſay experimentally, that by the Meditation chiefly of what has been here offer'd in theſe two firſt Contemplations, an unhappy Perſon, whom I had formerly often beſought, while he was in good Health, that he would ſeriouſly weigh theſe Things by himſelf (and who was wont, even 'till a few Weeks before his Death, where-ever he could ſpeak his Mind freely, to ridicule all ſuch as acknowledged and ſerved a GOD) was by GOD's Grace brought over to better Thoughts, and to a Conviction of his Exiſtence, as he confeſſed to me with his own Mouth in his laſt Illneſs.

CON-

CONTEMPLATION III.

Of some Particulars in the Mouth.

Section I. *Concerning the Teeth.*

TO begin then; let us first contemplate our own Body, and all the wonderful Structure thereof; which, tho' the most part of our Food, as Bread, Flesh, Fish, &c. consists of solid Bodies, cannot be nourished by them so long as they remain such, and are not first converted into Fluids; wherefore a Means was requisite to turn these solid Bodies into a liquid Matter, and even such as should be proper to support and nourish us.

For this Purpose there are *Teeth* planted in our Mouths, of which those that stand foremost are sharp and cutting, in order to bite off a Part of that Food which is taken in, whose Semicircular Figure is wisely adapted to a just Measure of the Piece to be bitten, and so as to be afterwards chewed with the most Conveniency, as every one may experience who makes his Biting greater or smaller: The second Sort are those that are called *Dog-Teeth*, and those are more pointed than Cutting, and seem to be particularly designed for something that is tougher and harder, and which cannot easily be penetrated by the former, in order to hold it fast, and so to divide it from the other Part.

Does there not appear a wise End in all this? Why are not the following Teeth which are call'd Grinders of the same Figure? Why are they flat and

and broad, and uneven with Cavities and Protuberances, as if Nature intended, that what was bitten off by the foremost, should be beaten small and ground by these latter, to which their Unevenness contributes, as it is in some Mill-Stones that are made uneven on purpose, in order to grind the better? If this is done by Chance, why don't the Grinders stand foremost, and the Fore-Teeth in the inward Part of the Mouth, which would certainly render Biting and Chewing very uneasie? How happens it, that almost all the other Bones are clad with a tender and sensible Membrane; but the Teeth, so far as they stand out of the Gums, with none, unless it were to avoid that Pain, which the Use of 'em in Biting would occasion by pressing upon such a Membrane?

Sect. II. *Of the Enamel of the Teeth.*

Can any one suppose that it is without Wisdom and Design (since the naked Bone can rarely endure the Air without Corruption, and the Covering it with a Membrane would be here useless and inconvenient) that the Teeth are surrounded with a hard Substance, which the Author of the *History of the* French *Academy of Sciences*, for the Year 1699, *p.* 48. calls the *Enamel*; wherewith they are, as it were, glazed round about, so far as they are exposed to the open Air; and which as soon as they lose, they rot and are corrupted. In *Tab.* I. *Fig.* 1. you may see a Representation thereof: The Line A C F H is that Part of the Gums out of which the Teeth appear; A E C and F G H are the Roots of the Teeth: The Parts A D C B and F L H I I shew the *Enamel* or Glazing, which consists of small Fibres running parallel to each other, that joyn sometimes at the

the Top, but below are ſeparated from each other: This Enamel covers the whole Tooth as far as it ſtands out of the Gums: M M are the little Holes thorough which the Nerves paſs into the Root of the Teeth of young People, but are cloſed in Old, as in N N; by which Means this Part of the Nerves, which are otherwiſe in the Teeth, is ſeparated from the remaining Nerves.

The Bone of a Tooth is remarkably harder than all other Bones, and is therefore thought by ſome to be of a petrified Subſtance, to the End that it might not become uſeleſs by Attrition: And whereas other Bones ceaſe growing after a certain Age, the Teeth, or at leaſt their Enamel, increaſes even to old Age, in order to make good the continual Wearing of 'em; this appears when we loſe a Tooth out of one of the Jaw-Bones, that which is oppoſite to it in the other becoming oftentimes longer than thoſe which are next to it.

Sect. III. *Of the Lips.*

To ſay no more of other Uſes of the Teeth, with reſpect to the Beauty of the Countenance, and particularly for Speech, which by their Means becomes intelligible, eaſie and diſtinct. Who can conſider the Structure of the *Lips* without Aſtoniſhment, and their Motion in ſuch various Manners? The Opening of them for the Reception of Food; the Cloſing of them again to prevent the ſame Food, whilſt it is chewed, from falling out of the Mouth; the Uſe of 'em in Humane Speech; by theſe the Children ſuck their Mother: And theſe, together with the Tongue and Cheeks, are uſeful in chewing the Food; which not being able to remain under the Jaws and Teeth, is by them, at every

every Turn, brought back again 'till it becomes ſmall, and ſufficiently moiſtened by the Spittle.

Sect. IV. *Of the Glands of the Mouth.*

Is it not likewiſe by a wiſe Contrivance, and not by meer Chance, that there are in the Mouth ſo many Glands or *Fountains of Spittle?* Since if the Food ſhould remain dry it could not be ſwallowed down, but with a great deal of Trouble; whereas the Moiſture that proceeds from them, by innumerable Orifices, is mingled with Food whilſt it is chewed; and this Liquor, or Moiſture, is brought thither by long Veſſels, and diſtant Glands, not only to the aforeſaid End, but (which is more) to give an Occaſion for the more eaſie Converting the ſolid Food, wherewith it is mixed in the Mouth, into a nutritious Liquid Subſtance in the Stomach. We ſhall not here mention the Property of Spittle in cauſing many Things to ferment, or other Qualities, which may be found in the Writings of thoſe who have enquired into them, becauſe we will not dwell too long upon this Subject.

Sect. V. *Of the Tongue.*

Before we take our Leave of the Mouth, I cannot forbear obſerving ſomething more therein, which every one that ſees the Effects of it, muſt needs be aſtoniſhed at: This is the wonderful Structure of the Tongue; and here I would freely ask all the Artificers in the World, whether any of them could have invented ſuch a Machine, which having neither Bones nor Joynts can produce ſuch an innumerable Variety of Motions; ſometimes making it ſelf long and thin, at other times ſhort and thick; and in a Minute ſtirring

and turning it ſelf after ſo many particular Ways, that one can ſcarce fancy any kind of Motion of which it is not ſuſceptible.

Can any Body think that there is neither Underſtanding nor Wiſdom made uſe of here by Him who has formed ſuch a wonderful Body, only by the Knitting together of ſome Muſcular Fibres (if we except ſome Glands, the Uſe of which is to moiſten it, as it becomes dry) and fix it in a Place where all theſe Motions may have their Uſe?

This Tongue lies in the Mouth, where the Sound that comes out of the Wind-Pipe paſſes thro'; and which, by the Motion of the Tongue, becomes diſtinct; and ſo forming all Speeches and Languages, produces this great Wonder, that a Man, by the Motion of ſuch an Inſtrument, can communicate the Thoughts of his Soul to another; whereas, if it were otherwiſe placed, or if it were not of ſuch a Texture and Property, the whole World would be brought into Confuſion: This may be obſerv'd in thoſe, who by Deafneſs or other Accidents have the Misfortune of not being able to uſe their Tongue: How great is the Trouble and Difficulty they find in expreſſing their Thoughts to other Men? In ſhort, every one may eaſily repreſent to himſelf what a Diſorder it would be, ſuppoſing all Men dumb, if we were obliged to make uſe of other Signs and Tokens, in order to carry on any Commerce or other Buſineſs with one another; not to mention the Prejudice which the Teaching of all Sciences, and in a Manner every thing that paſſes among Men, would ſuffer thereby.

The Tongue does alſo lie upon that Place, thro' which the Meat and Drink paſſes; and beſides its other Faculties, is a principal Inſtrument of Taſt. If it had not this Property, how many

People

People would eat without any Pleaſure or Satisfaction? Nay, ſo neceſſary a Work would be very tedious and irkſome to many.

Not to mention here expreſly that Service and Uſe of the Tongue which preſerves all Men alive, *viz.* by thruſting the Food, after it has been chewed in the Mouth, down the Throat; without which we ſhould not be able to ſwallow at all, or at leaſt but with great Difficulty; the Inconveniencies of which, all ſuch as have loſt this Faculty by Swellings in thoſe Parts, are very ſenſible of.

Sect. VI. *Of the Throat.*

Now if we paſs on to the Throat, whither the Food leads us from the Mouth and Tongue, and if we conſider the Structure thereof; can any one imagine that it was ſo contrived without any Wiſdom, that the Orifice, or Opening of the Throat, is dilated by three Pair of different Muſcles (ſee *Tab.* I. *Fig.* 2. B B, C C, D D,) like a Bag by ſix Hands, to the End that the Food, which the Tongue drives thitherwards, may be ſwallowed, and deſcend without any Trouble; being drawn up ſo much higher backwards, by the Muſcles D D, that the Food paſſing over the lower Brim thereof, and ſtriking againſt the hinder Part, ſhould not fail to find the right Entrance of the Throat, which being compoſed of a moiſt Membrane, would cloſe together, or at leaſt hinder the Swallowing, if thoſe Muſcles were not placed there.

Sect. VII. *Of the Wind-Pipe.*

But herein appears yet more ſenſibly the Deſign and Wiſdom of the Great Artificer, in order-

ing the Food to paſs over the Orifice of the Wind-Pipe as it goes to the Throat: For if any thing falls into the Wind-Pipe (which People commonly call *going the wrong Way*) every one knows what Diſorder it occaſions in them, ſo great ſometimes as to put them in danger of choaking; wherefore it is abſolutely neceſſary, if we would eat with Eaſe, and preſerve our Life at the ſame time, that the Wind-Pipe, or the Mouth of it, ſhould be cloſed when we ſwallow, and then immediately open'd again in order to draw our Breath: Now can any Body be ſo dull as not to obſerve this determinate End and Deſign of our Wiſe and Merciful Creator? Let him only take the Trouble of viewing the upper Part of the Wind-Pipe of a Sheep or a Calf, where he will ſee more plainly than can be ſhewn him here by a Figure, that there lies a Cartilage, called the *Epiglottis*, which being preſſed down by the Food, when 'tis ſwallowed, covers the Orifice of the Wind-Pipe lying under it, by which Means the Food paſſing over it, as if it were a Bridge made for that Purpoſe, in its Way to the Throat, is prevented from falling into the Wind-Pipe, which would often occaſion Coughing, Straining, and other greater Inconveniencies.

Now if this Cartilage ſhould remain lying thus upon the Orifice of the Wind-Pipe, the Breath would be ſtopt, and the living Creature immediately ſuffocated. Do we not here again diſcover a wiſe Deſign, that this *Epiglottis* is ſo contriv'd, as to riſe up like a Spring that has been preſſed down, or as ſome ſay, drawn up by Muſcular Fibres after the Food has paſſed over it? By which Means the Paſſage of the Breath is immediately open'd after ſwallowing, in caſe the Elaſtical Force of the ſaid *Epiglottis* ſhould be weaken'd by too much Uſe.

SECT.

SECT. VIII. *Convictions from what has been ſaid above.*

NOW let a Man conſider all theſe things together, as they appear in ſo ſmall a Place as the Cavity of the Mouth, and ſee whether he can ſtill ſuppoſe that all of them, ſo manifold in Number, ſo neceſſary to our Life and Well-being, could have met together in ſuch a narrow Circumference without any Deſign of the Maker, and by meer Chance or ignorant Cauſes? Can he not clearly diſcover therein a Wiſdom, Power and Goodneſs, which contrived all this, in order to ſupport this Part of the Humane Body, and to preſerve it from ſudden Death by Suffocation or Strangling? And let any one ſay, if he can, that in a Place not above a Span long, where ſo many Diſpoſitions of ſo many different Things, for the attaining ſuch weighty Purpoſes do appear; that all this is brought about, by Cauſes ignorant of their own Work.

SECT. IX. *About Sucking, and of Places from which the Air is exhauſted.*

BEFORE we conclude this Diſcourſe, I muſt add ſomething, which as often as I conſider it, does every time excite in me a new Aſtoniſhment.

All the Learned World knows the juſt Praiſes that have been given to the famous *Torricelli*, *Gueric*, *Boyle* and others, who were the firſt Inventors of the Art of producing a *Vacuum*, or Place void of Air, by the ſinking of Quick-Silver, or otherwiſe by Air-Pumps, whereby ſo many Secrets of Nature have been diſcover'd. And can we ſee without ſtanding amazed at the All-comprehending Wiſdom of our Great CREATOR, who has prepared and fitted the Mouth of all Men for an Inſtrument to produce the ſame

Effect? The Action which is called *Sucking*, is a plain Demonſtration thereof, and is performed by putting the Tongue and Lips together, or otherwiſe, only by leaving a little Cavity between them firſt open, and afterwards drawing the Tongue backwards, which makes a Hollowneſs that was not there before between the Tongue and Lips, and conſequently empties it of Air; or otherwiſe, by drawing the Tongue back makes the Cavity that was there larger, giving the Air that was in the Place more room, and ſo leſſens the Preſſure and Reſiſtance of it in that Place; by which Means the Liquor (into which one End of a Pipe is put, and the other into the Cavity of the Mouth, which has been emptied of its Air) being preſſed by the External Air, and finding in the Mouth little or no Reſiſtance, is forced up thither: The ſame Effect is ſeen in the Sucking up of Smoak by thoſe that take Tobacco.

Sect. X. *Sucking, as performed by Children.*

But that which ought to be not only ſurpriſing, but aſtoniſhing to every Body, is, that this ſo artful a Manner of producing a *Vacuum* is performed by Children newly born, and even by all the moſt irrational Creatures, which, by Sucking their Dams as ſoon as they come into the World, are already taught to begin to ſupport their own Lives. Can theſe know that the Air has an expanſive Faculty? That it preſſes all things with ſo great a Weight? That to cauſe the Milk to come out of the Breaſt with ſuch a Preſſure, there muſt be a *Vacuum*, or Place void of Air, made before the Orifices of the Nipples? That this Place muſt be ſo cloſed on all Sides, that tho' the Air, in order to Reſpiration, paſſing thro' the Noſtrils, can inſinuate it ſelf by the ſmalleſt Opening,

Opening, yet it must be prevented from coming into this *Vacuum*; for in such a Case the Sucking, or the Flowing of the Milk, would cease; all which things must be well observ'd by such as make Instruments proper for Sucking, as they are exactly followed by Nature.

Sect. XI. *Convictions from the foregoing Observations.*

Now let the unhappy Patrons of the desperate Sentiments of an *Epicurus* and *Lucretius* seriously consider these things with us, and see whether their Fundamental Principle can obtain here, *viz.* That all things are produced without a certain End or Design of the Creator, and that Men only finding 'em so prepared to their Hands, do make their Use of them. Is it to be believed that this can happen with Children, and all other Creatures, as soon as they are Born, which do not so much as know that there is such a thing as Air, much less how to apply it to this Purpose? Can any Man, endow'd with Reason, think, that the dullest and most ignorant of all Living Creatures are immediately capable to apply such a Machine to its right Use? Whereas Men of the greatest Learning and Understanding will readily own how difficult it is at first for them to understand and use the same rightly; every one can witness this the first time he takes an Air-Pump into his Hand.

And to give a convincing Proof that the Instruments made use of for Children and young Creatures in Sucking, are produc'd by infinite Wisdom for that Purpose, we need only enquire into the wonderful Structure of the Muscles of the Lips and Tongue, and the fleshly Fibres of which they are composed, and which are so well describ'd by all Skillful Anatomists. If we would allow Reason to take place, we should be sufficiently satisfied

by this ſingle Inſtance; that, becauſe that Paſſage is ſtopt in Sucking, which upon other occaſions is prepared for the Air, the adorable Creator, and great Supporter of all things Living, has ſo diſpoſed the Noſtrils, that they may ſerve for Breathing, during the Action of Sucking; and ſo this great Work, ſo neceſſary to New-born Creatures, might not be obſtructed at every turn. A Proof of this is ſeen in Nurſes, who, when they have a mind that the Child ſhould leave off Sucking, ſtop their Noſe with their Finger, by which Means their Breathing that way being hindred, they immediately quit the Breaſt, that they may draw in the Air by their Mouths.

CONTEMPLATION IV.

Of the Throat, Stomach, and Bowels.

SECT. I. *Concerning the Throat.*

LET us now go on, and contemplate the Structure and Function of the Throat, as it extends it ſelf from the Mouth to the Stomach.

The Food being ſufficiently chewed in the Mouth, and being conveyed in the Manner as has been before deſcribed, into the Throat, thro' the Orifice or Opening thereof, (*Tab.* I. *Fig.* 2. E) if it were to deſcend by its Weight only, it would require a great deal of Time to paſs into the Stomach, thro' this Tube, becauſe of its being Membranous and Moiſt, ſo that the Parts of it would ſtick together; eſpecially, if any piece of Food, by its Largeneſs and Solidity, ſhould extend the Throat in its Deſcent,

ſcent, and thereby contract thoſe Parts that are above and below the ſaid Food; to ſay nothing of the Throat of Beaſts, which lies Horizontally, or even aſcends when they feed upon the Ground; in ſuch a Caſe, I ſay, that which is ſwallowed would not be able to proceed into the Stomach.

Now, to prevent all theſe Inconveniencies, it has pleaſed the Gracious Creator, to place there a Muſcle, A A, (which is here repreſented, cut thro', and is by ſome taken for two) the Fibres of which encompaſſing the Throat, and contracting themſelves, do thereby ſqueeze it, and ſo force the Food to deſcend; for whatever the Cauſe be, it is experimentally true, that all the Muſcles of the Body operate, by contracting or ſhortning their Fibres.

Sect. II. *The Strait and Circular Fibres of the Throat.*

Can we further conſider the wonderful Order in which this Tube is framed, without acknowledging a Wiſdom therein that intended the Protruſion of the Food into the Stomach? Since the outward Membrane E being taken off and laid aſide at *a* (which is to be underſtood in all thoſe Places where you meet with the Letter *a* in this Figure) the Muſcular Fibres F ſhew themſelves, deſcending perpendicularly, or lengthwiſe, according to the whole Extenſion of the Throat; having others under them, as in G, which encompaſs the Throat like Rings or Circles: Let us now imagine, that theſe two ſorts of Fibres, *viz.* thoſe that run lengthwiſe at F, and the Circular at G, were contracted; we ſhould then perceive that theſe laſt Circular Fibres, ſhortening themſelves behind and above the Part where the Food lies, protrude the ſame downwards, after the ſame

Manner

Manner as the Women that make Sauſages are wont to do, by ſqueezing the Matter with their Hand, in order to make the ſame go forward into the Bag or Gut that is to contain it; whilſt in the mean time, the long Fibres, by ſhortening themſelves likewiſe, do widen the Place thro' which the Food is to paſs, to the End it may be the more eaſily thruſt down by the Contraction of the Circular Fibres.

Now that this Motion and Progreſſion of the Food towards the Stomach is perform'd by ſuch a kind of Force, and not by its own Weight, is plain by Childrens ſwallowing their Victuals into the Stomach upwards when they ſtand upon their Heads: Upon which Account every one of us is moſt highly obliged to the Goodneſs of our Creator; becauſe otherwiſe no body could take in any Food in the Poſture of lying down; which how exceeding inconvenient it would be to Sick and Diſtemper'd People, is not neceſſary to be farther deſcribed.

Sect. III. *Of other Tunicles or Coats of the Throat.*

One Thing further ſeemed requiſite towards rendering the Paſſage of the Food yet more eaſy, *viz.* That the Tube above-mention'd, for the better performing its Function, ſhould be kept conſtantly moiſt; foraſmuch as the Food being ſometimes dry, its Motion and Deſcent would be perform'd more ſlowly and with greater Trouble.

Can we therefore diſcover no Wiſdom herein; that in order to produce ſuch an Effect, the ſaid Throat has a Tunicle full of Blood-Veſſels, that is of Veins and Arteries, (See *Tab.* I. *Fig.* 2. H.) and yet another under that at I, which is called

called the *Glandulous Tunick*, becauſe it is full of little Glands, from whence a Liquor is ſeparated from the Arteries, which renders the under-lying K, called the *Nervous* Coat, ſmooth and ſlippery, that it may be fit for the ſaid Uſes? It ought likewiſe to be obſerved here, that theſe Glands in this Coat or Tunicle are placed exactly between fleſhy Fibres for this Reaſon, that thereby they may be more or leſs preſſed, in order to diſcharge their Moiſture according as there is Occaſion; for which Cauſe likewiſe, this laſt Tunicle is endued with a ſoft Woolineſs on the inſide, which in ſome meaſure is able to ſtop and hinder the Moiſture from paſſing away till it has performed its Function of making the Parts ſlippery; when there is too little of this Moiſture, and the Throat is too dry, that which we call Thirſt, ſeems to be produced, which is a natural Warning that Moiſture is there wanted.

Sect. IV. *Convictions from the foregoing Obſervations.*

Now can any one imagine, that all this wonderful Structure of the Parts of the Throat is produced by Chance, without any View or Reſpect to the Order and Uſes for which they are deſigned? which beſides thoſe Artful Inſtruments for forcing the Food to deſcend into the Stomach, beſides the Veins that feed it, and by the Moiſture which is ſeparated in the Glands, contribute to make it ſmooth, has likewiſe in it ſelf the Property of Warning us when we ought to moiſten it, at ſuch Times as its own Natural Juices are not ſufficient to perform the ſame, by reaſon of the Dryneſs of the Food, or other Accidents; and if any Body does perſiſt in affirming that all this is owing to Chance, why ſhould he be aſhamed to ſay, that a Spout or Pipe, by which

which the Rain-Water is conveyed from the Top of a Houſe into a Ciſtern (which in Compariſon of the Structure of the Throat, has nothing of Skill in it) was produced in that Place by meer Accident, and without any End or Deſign?

Sect. V. *Of the Stomach.*

Now in Caſe the Stomach D C D T, (*Tab.* I. *Fig.* 3.) were as narrow as the Throat E A, or as the Inteſtines G H H I I, both which make one and the ſame continued Tube with the Stomach, and that the Food ſhould paſs thro' all of them with equal Force and Swiftneſs, it would not be poſſible that the ſame ſhould be rightly prepared, or as they call it, Macerated and Converted from a ſolid Body into a fluid Matter proper for Nouriſhment.

And here again do we not ſee plain Footſteps of a Wiſe End in contriving the Stomach to be ſo much Larger and Hollower, in order to contain, at once all the Meat and Drink that is ſent down into it? and beſides of ſuch a Structure, as not to ſuffer the ſame to paſs too ſoon thro' it, as it happens in all the other Parts of this great and long Tube?

Thus we ſee, that the Food deſcending from E A into the Stomach B, is hinder'd from proceeding further, by Reaſon that the extreme Part or End of the Stomach C, by which the Food is to be diſcharged, is ſo much higher than the Belly of it in which it lies; whereby it is obliged to remain there for a while, in order to be turned into a ſort of Pap, which the *Anatomiſts* call *Chylus* or *Chymus*; or as ſome will have it, till the Quinteſcence thereof be extracted.

And what I cannot paſs over here without a Note of Admiration is, That according to the Obſervations

Obſervations of that great Anatomiſt *Verheyen*, the diſcharging Part C is not raiſed up to that heighth, but juſt at the Time when the Stomach is full and extended, and ſo is capable of hindering the Food from paſſing too ſwiftly thro' it; whereas otherwiſe, when the Stomach is empty, it ſinks down much lower. Can any one ſee this without diſcovering the Deſign of the Great Creator, to continue the Food a ſufficient Time in the Stomach?

Sect. VI. *The Fluids of the Stomach and Muſcular Valve.*

Now whether the Conſumption of the Food happens after one or the other Manner, it was neceſſary in both Caſes, that there ſhould be more Moiſture mixed with it in the Stomach, in order to put it into a Fermentation, or otherwiſe to convert it into that fluid Matter called *Chyle*.

Can it now be thought, that meer Chance produced ſuch a vaſt Number of Arteries in the Stomach as you may ſee at D D, *d d*; and ſuch a wonderful Number likewiſe of Nerves, ſpreading like ſo many Branches out of E and F, which convey into it ſuch a Moiſture and Nervous Juice by the Glands that are placed on purpoſe? that together with the Spittle which is mixed with the Food in Chewing, they may make a new Liquor proper for the Attrition or Breaking of the Food; and to the End that it may remain long enough therein, the extreme Part of the Stomach B (*Tab.* I. *Fig.* 4.) is ſhut up with a Muſcle that encompaſſes and contracts the ſame, and which therefore cannot be opened but with a greater Force or Preſſure.

Sect.

Sect. VII. *The Fibres of the Stomach.*

The Food having remained ſome Hours in the Stomach, in order to its Change, muſt afterwards purſue its way for the Nouriſhment of the whole Body: Can any one then think that it happens without the eſpecial Wiſdom of God, that every Thing is found in the Stomach adapted in the beſt Manner to promote this Purpoſe?

1. By the inſenſibly oblique Aſcenſion from the Bottom of the Stomach to the Paſſage C (*Tab.* I. *Fig.* 3.) in order to diſcharge the ſame: Whereas if this laſt Orifice was of the ſame Structure as that at A, thro' which the Food paſſes into the Stomach, it is plain that the Diſcharge thereof could not be performed but with very great Trouble.

2. Add to this, that the external Fibres of the Stomach are extended length-wiſe in it, and being ſhorten'd in their Operation, they likewiſe render the Stomach ſo much ſhorter; and in order to exert themſelves with greater Strength at both the Orifices A and C, as alſo at the Bottom of the Stomach, they become Muſculous.

3. Moreover (*Tab.* I. *Fig.* 4.) other ſtronger Fibres D encompaſs the Stomach annularly, and croſs the former, which being drawn together, make the Stomach narrower.

4. Under theſe there lie yet another Row of Fibres (*Tab.* I. *Fig.* 5.) which run obliquely A, extending themſelves from the uppermoſt Part of the Stomach to the Bottom thereof, drawing obliquely the End M towards the Beginning N.

Now let any one ſuppoſe, that he held this Stomach C T full of a fluid Matter in his Hand, and that it was to continue in the ſame Poſition in relation to the Heighth of its lower End C:

Could

Could he poſſibly invent a better Way to diſcharge the ſaid Matter by the Orifice C, as firſt by cloſing the Orifice A, and afterwards contracting the Stomach, by pinching it together length-wiſe from C to A; by which Means the incloſed Matter being thruſt againſt the Left end of the Stomach T, muſt neceſſarily be forced out at the Right end where the Orifice C is.

Now how particularly ſerviceable the ſtrong Muſcular Fibres B (*Tab.* I. *Fig.* 5.) are thereto, is plain, *firſt*, becauſe they encompaſſing the Left Orifice of the Stomach I, do ſhut the ſame exactly at the Time when the Food is thruſt out at the other Orifice K, to the End that the Chyle may not be driven back again into the Throat thro' the Orifice I P. *Secondly*, Becauſe theſe Fibres B running length-wiſe, are inſerted in the right Paſſage of the Stomach K, which when they become ſhorter, they draw towards themſelves, and by this one Action do at the ſame time contract or ſhorten the Stomach from M to N, and whilſt they ſhut one Orifice I, they do in ſome manner dilate the other K; inſomuch that it is impoſſible, when all theſe Fibres are contracted and perform their Function, but that the Chyle ſhould be protruded by the Orifice K K.

How comes it to paſs now, if all this be done by Chance, that theſe Fibres of the Stomach run, or are extended ſo differently, from thoſe of the Throat, and thoſe of the Bowels which ſhall be accounted for hereafter? And whence comes it, that each of them is adapted, in the moſt proper Manner, to its right Uſe, and the Functions that are required of it? Can the wonderful Structure of the Fibres be deemed Accidental? Why don't they ſay the ſame of the Preparation of the Ropes that are uſed in the drawing up of a *Rammer*, in which, comparatively, there is very little Art.

Sect. VIII. *The Mucilage or Slime of the Stomach.*

Besides all this, there is often a Neceſſity in ſome Perſons, for an Acid Matter to compleat the Diſſolution of ſome kinds of Food; of which Nature are alſo ſeveral Medicines, ſuch as Vinegar, Verjuice, Lemon-Liquor, Muſtard, Pepper, Root, and almoſt all Spices, all Salts, as well the Common as Volatile, and others, which are all Acid, and nevertheleſs very neceſſary on ſome occaſions. Now, foraſmuch as the Stomach is Membranous, and the Membranes thereof extreamly ſenſible, there was danger, that by ſuch ſharp Matters, it might either be affected with Pain, or elſe irritated to Vomiting or other irregular Motions: Can we therefore here, without Thankfulneſs and Aſtoniſhment too, obſerve, how it has pleaſed our Gracious Creator, with great Wiſdom to provide againſt the ſame, by Cloathing the innermoſt Part of the Stomach and Bowels with a thick and tough Slime, (whereby they are defended from the Corroſion of thoſe Sharp Matters) which is ſtopt there, and adheres to ſmall Fibres, that ſtand ſtreight up on the ſides of the Stomach, like the Silk Thread in Velvet, to prevent the ſaid Slime from being carried away immediately by the Food that paſſes through the Stomach.

Can any Body now, conſidering what has been here ſaid about the Stomach, (tho' for Brevity ſake I have deſignedly omitted ſeveral remarkable Circumſtances) remain unconvinc'd that it was a Great Creator who, in order to diſplay his Wiſdom and Goodneſs to Mankind, has produc'd all this in ſuch a beautiful Order? And can he, without Scruple, aſcribe this whole Structure to Ignorant Cauſes; the rather, becauſe any one of theſe Circumſtances

cumſtances failing, very diſmal Conſequences, and even Death it ſelf, would ſometimes follow.

Sect. IX. *Of Hunger.*

To ſay nothing more about the Stomach, which ſeems plainly to prove the Deſign of Him that made it; are we not particularly obliged to return him our Thanks for having been pleaſed, over and above, to add to the Structure of the Stomach, beſides ſo many other neceſſary Uſes, the following Property, *viz. Hunger*, by Feeling which, we are acquainted, that we ſtand in need of new Food and Refreſhment, of which, without ſuch a Warning, we ſhould not be ſenſible oftentimes, till we become weak and faint, and unfit for Buſineſs for want of the ſame.

He muſt be miſerably blind who cannot diſcover a Wiſe and Gracious Maker of all theſe things; or that can perſwade himſelf, that their skilful Structure and ſo many Conveniencies and regular and well adapted Uſes, can be produced by meer Chance or irrational Cauſes.

Sect. X. *The Uſes of the Guts.*

Let us now paſs on with the Food to the Bowels or *Guts*; to know the Conſtruction of which, you may conſider the Tube (*Tab.* I. *Fig.* 2.) repreſenting the Gullet and the Stomach as Parts of the Bowels to which they are annex'd, ſince the Membranes and Tunicks thereof are for the moſt part Analogous with thoſe of the Guts, and ſo are its Motions too, by which the Matter contained therein is protruded; for which reaſon we ſhall not repeat the ſame here.

This Tube has the following great Uſes; (*Fig* 1.) Firſt, that it ſeparates that which is proper for Nouriſhment from the unneceſſary Parts, convey-

ing it to the *Venæ Lacteæ*, or Milky Veins; Secondly, that it carries the Remainder of the Food to the *Inteſtinum Rectum*, in order to be there diſcharged.

Now to ſpeak of this laſt in the firſt place, it will not be neceſſary to ſay, after the Deſcription of the Gullet and Stomach that this is alſo performed wiſe by the long and circular Fibres; which do like-both here produce, by contracting and ſhortning themſelves, a Protruſive Motion, which is called by the Anatomiſts, *The Periſtaltic Motion.*

Sect XI. *The Meſentery.*

You may ſee how theſe Bowels are placed in the Body, in *Tab.* I. *Fig.* 3. Now in caſe this Tube of the Bowels was ſhort, there would be danger that the Chyle, or Nouriſhing Juice, extracted from the Food, might in a great meaſure be diſcharged with the uſeleſs Part thereof. Is it therefore without a Deſign of the Maker that there are ſo many Meanders or Windings therein; ſo that it is very near ſix times the Length of a Man? And particularly, that notwithſtanding all its Turnings, it is faſten'd in ſuch a manner to the *Meſentery*, that it is not poſſible for the Food, either to miſtake its way, by reaſon of the length of the Inteſtines, or to take any ſuch Turn, as that the way thro' which the Chyle paſſes, ſhould be ſtopt; as may be ſeen in *Tab.* I. *Fig.* 6. where G G repreſents the Meſentery, and L L the Bowels or Guts faſten'd to it, but both extended.

Now can any one ſee without Aſtoniſhment, that in this Membrane (which being only flat and round, would be too big to lie conveniently in the Belly, in caſe it ſhould be faſten'd to ſuch a great Length of the Bowels in its Circumference) ſuch a wonderful Method is uſed by our moſt wiſe Creator for that purpoſe, *viz.* by pleating it upwards and downwards upon the Edge of the Meſentery,

juſt as they uſed to do the Ruffs in old Times? An inſtance of which may be ſeen in that Part of the Inteſtines deſcribed by P Q, R S, (*Tab.* I. *Fig.* 6.) and more fully in the 2 *Fig.* of the 18 *Tab.* of *Verheyen*, in the ruffled Edge B B, of this expanded Meſentery; to which, that we may not multiply the Figures too much, we refer thoſe that are deſirous to ſee it in its true State. It is by this means, that tho' the ſame is not above two Spans Breadth in a Man of a middle Size, yet by theſe Pleats and Folds it acquires ſo much Length, as to afford ſufficient room for the Tube of the Inteſtines, which is ſo much longer, to be faſten'd to it. Now, in caſe this Problem had been laid before a great and able Mathematician, Would not he have thought that he had acquired no ſmall honour, by ſolving it after this Manner? And can any Body fancy that this is performed by Chance, or without Wiſdom?

Sect. XII. *The Glands of the Inteſtines.*

Now whilſt the Nutricious Juices are continually ſeparated from the Food in the Bowels, and by Openings, which are found in their Membranes, paſs into the External Parts, as we ſhall ſhew hereafter; it ſeems as if it could not be avoided, that the Remainder being thereby become dryer, ſhould be hinder'd from proceeding conveniently on its way in this Tube: To remove this difficulty, the adorable Creator has been pleaſed to place ſeveral Glands in the Inteſtines, from whence they filtrate a Liquor ſufficient to ſoften the Excrements, beſides others proceeding out of the Glandulous Coat of the Bowels themſelves, which help to render the Paſſage ſmooth and ſlippery, and ſo fit for the intended Service.

Can this likewiſe be ſaid to be done by Chance? Why then are theſe Glands ſmaller and fewer in the thin Gutts G, H H, I I, (*Tab.* I. *Fig.* 3.) which lie next to the Stomach, where that which is in it has a great deal of Chyle and Moiſture? And why are thoſe Glands multiplied about the End of thoſe thin Gutts, unleſs it were that the uſeleſs Matter, being by the Separation of the Chyle grown dryer, wants more Moiſture to render it ſo fluid; and to the End, that what ſtill remain'd in it of the Chyle, may be ſqueezed out of it; after the Manner of the Apothecaries, who, in order to extract the Juices from their Druggs when they are pretty dry, put ſome Liquor in while they are pounding them? Laſtly, Why are thoſe Glands in the thick Guts, M, N N N, O, that lie fartheſt from the Stomach, and where the Matter to be diſcharged is in a manner diveſted of all its Chylous Juice, the biggeſt of all; unleſs it be, that the greateſt Moiſture is there requiſite to prevent its being too hard?

Sect. XIII. *The Wrinkles, Valves, and* Inteſtinum Rectum.

Now, not to mention the Wrinkles of the thin Guts; the uſe of which is to hinder the digeſted Food, that has ſtill ſome Chyle in it, from paſſing too ſwiftly thro' thoſe Orifices that are made to receive the Chyle; nor the great *Valve* K, at the end of thoſe thin Guts, whereby the Matter, that is hardly now of any further Uſe, is hindred from going back: Why are the thick Inteſtines larger, and furniſhed with ſo many Separated Places; unleſs it be to collect the Uſeleſs Matter therein, and to the End, that People may not be too frequently obliged to Diſcharge the ſame?

Is

Is it not therefore very plain, that the *Inteſtinum Rectum* O P, is only contrived for Diſcharging the aboveſaid Matter? Why does it deſcend ſtright forwards, unleſs it were, that the Diſcharge of the ſaid Matter ſhould not be obſtructed by unneceſſary Windings and Turnings?

Is all this made without ſuch a Deſign? Why is there a round contracting Muſcle P, which, like a Ring, pinches this Bowel at the end of it? It is not to hinder an inceſſant Protruſion of the Excrementitious Parts, by the continual Periſtaltic Motion of the Inteſtines: And ſince that in ſeveral Diſcharges, when the Matter is hard, the *Inteſtinum Rectum* O P, is preſſed and ſinks downwards, we may ſee that the two Muſcles, Q P, and Q P, are placed there on purpoſe to ſecure it; for by their Aſſiſtance, the ſhutting Muſcle, and the *Inteſtinum Rectum*, are drawn back again after a difficult Diſcharge, and made to aſcend by the ſhortning their Fibres.

Sect. XIV. *The Uſes of the Oblique and Lateral Muſcles of the Belly.*

And foraſmuch as the Protruſive Motion of the Bowels is not ſometimes ſtrong enough alone to diſcharge the Excrementitious Matter; ought we not likewiſe herein to adore the exceeding great Wiſdom of the Creator, who, beſides the *Diaphragma* and Meſentery, has after ſo wonderful a Manner made the whole Covering, or Tegument of the Belly, to be aſſiſting thereto; by which Means, the Expulſive Force may be render'd incomparably greater, as often as there is any occaſion for it?

In order thereto, People are wont, firſt, ſtrongly to draw in their Breath; by doing of which the Midriff lying juſt above the Stomach, ſo violently

preſſes upon all the Bowels, ſo that unleſs they oppoſe it on purpoſe, the whole Belly riſeth therewith, to the End, that the Gutts may be preſſed more cloſely together.

Now ſince the Bowels, thus preſs'd down by the Midriff, are forc'd to dilate themſelves outwardly in the Belly; unleſs the extended covering of the Belly did again contract it ſelf by the Action of its Muſcles, and preſs the Bowels together with a ſtrong Force, the Excrements cou'd not be protruded thro' the *Inteſtinum Rectum*: But ſince that Inteſtine is open, and at the ſame time the Bowels are preſs'd together from all Parts; the Matter contain'd in them, muſt be protruded thro' the Orifice of the ſaid *Rectum*.

Now, how wonderfully this Comprehenſive Force is produced by the Muſcles which compoſe the Coverings of the Belly, is plain to thoſe that are acquainted with the Structure thereof.

To give you ſome Notion of it here, without mentioning the uſual Coverings which the Belly has in common with many other Parts; (*Tab.* II. *Fig.* 1.) A is the *Cuticula* or upper Skin, B the *Cutis* or Skin, C the Fat, D the fleſhly Tegument or Covering; the External Parts thereof to conſiſt, on both ſides, *firſt*, of the Muſcle G, the Fibres of which deſcend obliquely from the *Vertebræ* of the Loyns to the *Linea Alba* K K, which runs downwards from the Breaſt-bone through the Navel L, to the *Os Pubis*, and is of a Strong and Fibrous Structure, in order to reſiſt the Force of the Muſcles drawing againſt one another on each ſide: The Muſcle of the ſame Name and Kind belonging to the other ſide, is laid open at O, in order to ſhew that which is under it. *Secondly*, we ſee another pair of Muſcles lying under the former the Fibres of which running upwards obliquely from the *Vertebræ* to the aforeſaid *Linea Alba*,

K K,

fronting Page 50.

TAB. I

Fig. 2



Fig. 3



Fig. 6

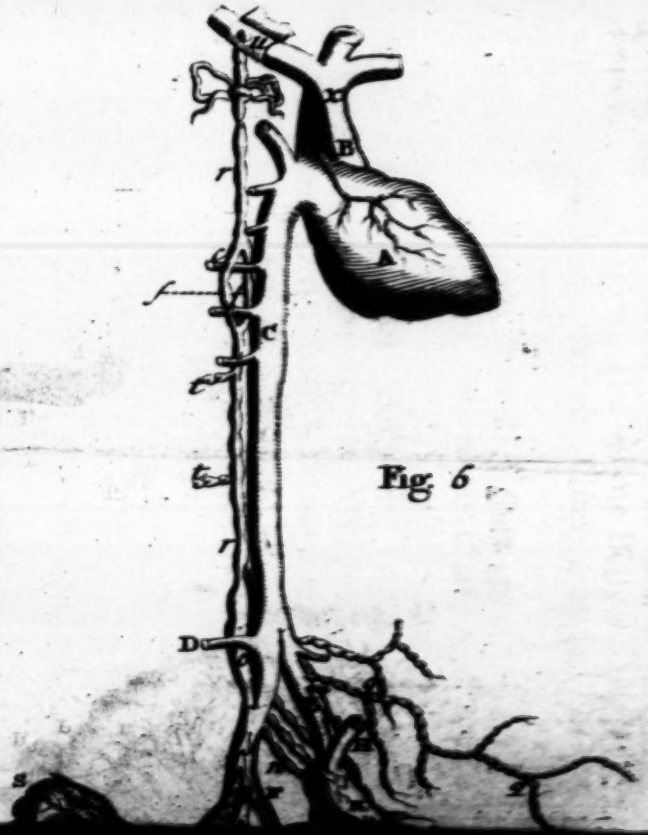




Fig. 1

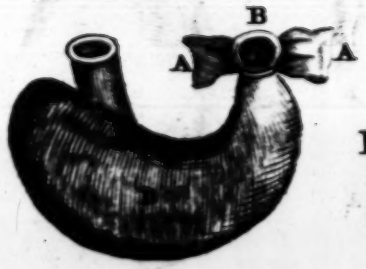
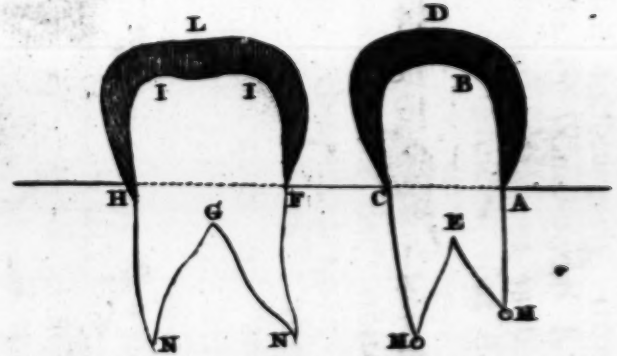


Fig. 4



Fig. 5



K K, do croſs thoſe of the firſt Muſcle; as appears here at M, on the one ſide, under a part of the firſt Muſcle, which is turned up; and on the other ſide at P, where it is fully ſeparated. *Thirdly*, There are a pair of Muſcles that lye underneath the ſame, on the right ſide at U, the Fibres of which are extended laterally or croſs, and not obliquely, from the *Vertebræ* to the *Linea alba*, or White-line K K: The tranſverſe Muſcle of the left Side is not viſible in this Figure, becauſe of the Muſcles that lie upon it; called the *Lateral*.

Let us now ſuppoſe, that theſe two loweſt Lateral Muſcles V, do encompaſs the Belly quite round, and in that Manner compoſe a Cavity, which contains the Bowels; and further, that all the Fibres of which they are made up, are ſhorten'd or contracted: It is plain, that the Cavity has thereby a leſſer Circumference, and conſequently muſt be narrower; and ſo the Bowels therein contain'd will be preſſed together on all ſides.

But ſince thoſe Muſcles are not only ſerviceable in the Evacuation of the Bowels, but likewiſe of the Bladder, and even in the Labour of Child-bearing Women, to whom they are of the greateſt Uſe in that important Caſe; it was neceſſary that this Preſſure ſhould be performed with very great Force; for which reaſon the Wiſe Creator has placed another pair of Muſcles (one of which is repreſented by M) upon the *Lateral*, the Fibres of which running obliquely upwards, as is ſaid before, and ending in the *Linea alba* K K, when they operate and become ſhorter, do in like manner ſtraiten the Belly; but they do alſo at the ſame time (as is well known to the Mathematicians) by their Obliquity extended upwards, as it were, draw down the whole *Linea alba* K K. Now to obviate the Inconveniencies that might proceed from hence, the Fibres of the Muſcles G, that lie upon theſe,

do run with a quite contrary Obliquity downwards; whereby the Belly is not only ſtraightned with a new Force, but the *Linea alba* K K, is again drawn upwards by this contrary Obliquity.

Sect. XV. *The Uſe of the Pyramidal Muſcles.*

Now if each Pair of theſe laſt oblique Muſcles operated with like Force upon the *Linea alba*, and that the ſame was drawn as much upwards by one Pair as downwards by the other, they would balance one another; and this White-line K K, would remain in its Place, without moving one way or the other: But ſince theſe laſt and outmoſt deſcending Muſcles G, are much Larger and Stronger than thoſe that lie under at M, it muſt follow, that whilſt they operate together to diſcharge the Belly, by this over-ballance of Force, theſe Fibres or White-lines K K, will be conſtantly drawn ſomething upwards.

Can it now be brought about by Chance, that we meet with a Pair of Muſcles S and T, under the *Os Pubis* (the laſt of which, T, is ſhewn ſeparated, and hanging downwards out of its Place) which, from the Figure of them, are called *Pyramidal*, and whereof the Fibres do only run upwards along the White-lines to K, or about as high as the Navel, ſo that it is very plain to every Body, that being ſhorter at S, and conſequently their Fibres being drawn downwards the *Linea alba*, to which the Fibres are faſten'd, muſt likewiſe follow downwards; and therefore theſe *Pyramidal* Muſcles ſeem to be made uſe of as a Balance of the Force, by which the deſcending Oblique Muſcles at G, do exceed the aſcending Oblique ones at M; and whereby, if not prevented by the *Pyramidal*, the White-lines would otherwiſe be mov'd upwards? This Opinion is confirmed; for-

foraſmuch as in many Bodies there are found but one of theſe *Pyramidal* Muſcles, and not always juſt two; ſince one that is big enough can anſwer the aforeſaid Uſes. Nor yet are the ſame neceſſary, when the aſcending and deſcending Oblique Muſcles are of equal Strength, as has been ſometimes obſerved.

Sect. XVI. *The Uſe of the Right Muſcles.*

But, beſides all this, there ſeems ſtill to remain the following Inconveniency; that the Belly being ſtreighten'd by theſe Muſcles with ſo great Force only Side-ways, the Inteſtines would hereby be preſſed as much upwards as downwards, and would likewiſe be driven with too great Violence upwards againſt the Midriff; ſo that the flexible Structure of the Cartilages would be raiſed upwards, by which Means the Protruſive Faculty would be weaken'd. To prevent which, and that nothing ſhould be deficient in this great Work, the Wiſdom of the Sovereign Creator ſeems to have faſten'd two other Muſcles, Q Q Q, called the *Right* to the *Os Pubis* at S, after ſuch a manner, that their other Extremities, Y Y, ſhould be faſten'd to and about the Breaſt-bone; whereby theſe being contracted, or made ſhorter in their Fibres, draw the Ribs, with their Cartilages (which terminate in the Breaſt-bone) downwards; and ſo they do not only hold faſt to the Places to which the Midriff is fixt, but likewiſe hinder the ſame from bending upwards by the ſtrong Preſſure of the Bowels againſt the Midriff, when thoſe Bowels are thruſt upwards and downwards by the aforeſaid Annular Muſcles of the Belly.

There are likewiſe ſeen in the Right Muſcles Q Q Q, three or four *Lateral* white Fibres, R R R; which do moſt commonly divide each Right Muſcle

Muſcle into four other, following one another, to the End, that theſe Muſcles may perform their Function by a leſſer Contraction, and proportionably by a leſſer Tumifaction, and ſo not take up too much room; which otherwiſe, in caſe the Fleſhly Fibres of the *Os Pubis* ſhould extend themſelves to the Breaſt-bone, would not be perform'd ſo regularly or conveniently.

The other Uſes which are aſcribed by the Anatomiſts to theſe *Right* and *Pyramidal* Muſcles, may be ſeen and conſider'd by every one in their Writings; we have dwelt long enough upon them here already.

Sect. XVII. *Orifices in the Muſcles for the Seminal Veſſels.*

He that is not ſatisfied, that all theſe things are performed for Wiſe Purpoſes, let him caſt his Eyes farther in *Tab* II. *Fig.* 1. upon the Orifices deſcribed by the Letter I, as they are found in the three Muſcles; thro' which, at the Groin, there goes the Tube W, thro' which the Seminal Veſſels in the Males, and the round Ligaments of the Matrix in the Females do paſs; and conſider whether ſuch neceſſary things as theſe are placed there by Chance.

Sect. XVIII. *The Voluntary and Spontaneous Motions of the* Inteſtinum Rectum.

To add ſomething more to what has been ſaid above, and which ſeems to me ſufficient not only to ſettle a Sceptical Mind, but even to convince an Obſtinate Atheiſt; let both theſe unhappy Men ſeriouſly conſider, that in this great Length of the Tube of the Bowels, which is continued from the Stomach to the *Inteſtinum Rectum*, no Body can encreaſe or diminiſh the Contractions or Wrings

ings

ings of the ſame; inſomuch, that all thoſe Motions (whereby that which is in the Bowels is protruded and diſcharged) are quite out of the Power of his Will; but if the ſame ſhould have place likewiſe in the loweſt Part of the *Inteſtinum Rectum*, Mankind could never have any command over their Natural Evacuations, in order to retain or diſcharge them, as occaſion ſhould require. And can a Man yet doubt, whether there be a God that has wiſely and graciouſly order'd all theſe things, when he perceives, that in the whole Structure of the Bowels, it is the *Inteſtinum Rectum* only, into which Nerves are derived from the *Medulla Spinalis*, or Marrow of the Back-bone; yea, that the Motion of that Bowel alone is ſubject to our Will, for the Prevention of ſo many Inconveniencies, which it would otherwiſe be impoſſible to avoid?

CONTEMPLATION V.

Of the Venæ Lacteæ, *and* Ductus Chylicus.

Section I. *The Tranſition.*

AFTER having traced the greateſt part of the Food as low as we could, let us now turn back again to the Stomach, in order to obſerve the Ways and Paſſages by which our merciful Preſerver has been pleaſed to conduct the Chyle or Nouriſhment that is extracted for our Food, in order to prepare and render it more uſeful

ful for making good what is waſted in our Bodies.

Not to mention in this Place the curious and skilful Structure of the *Gall-Bladder*, and the Veſſels, which coming out of that, and of the *Liver*, do continually introduce a great quantity of Gall into the *Duodenum*, where it mixes it ſelf with the Food that is ſent thither thro' the *Pylorus* from the Stomach; but more particularly, as often as by the drawing in the Breath, the Midriff deſcending, preſſes upon the Liver, and thereby ſqueezing the Gall-Bladder (which lies within the Liver) forces out the Gall through a Veſſel that reaches from its Bladder to the Inteſtines. To ſay nothing here of that Liquor that proceeds from the *Pancreas* or Sweetbread (a great Gland lying under the Stomach) which mingles itſelf with the extruded Gall, about four or five Fingers below the *Pylorus*, or lower Orifice of the Stomach, and moſtly by the ſame Paſſage. Not to enter here upon enquiring into the Uſes of both theſe; whether, for inſtance, they ſerve together to ſeparate the Chyle from the groſſer Parts of the Food; or to preſerve the ſame from Corruption, by the Bitterneſs of the Gall; or to render it more Fluid, or to incorporate thoſe Parts of it, which cannot otherwiſe be eaſily mixed, ſuch as the fat and watry Parts; or to qualifie the Bitterneſs of ſome, by the others; or, for any other Purpoſes, which, by a more nice Enquiry into the Nature of them, are daily diſcover'd: But ſeeing that the determinate Uſe of each of theſe has not yet been decided, we ſhall confine our ſelves to thoſe things only, from which we can draw ſuch undoubted Concluſions, as are more than ſufficient to prove abundantly the Perfections of our Maker.

Sect. II. *The* Venæ Lacteæ *and* Receptaculum Chili *in a Dog.*

To proceed then; If there were no Lateral Orifices or Openings in the Membranes of the Duct of the Inteſtines, (as there are none in the Throat, for inſtance, and Stomach) the Chyle or Juice, which becoming Blood, ſuſtains the Body, would be diſcharged at the ſame time, together with the groſſer Parts that paſs thro' them; and Mankind would conſume away and die for want of Nouriſhment: Can it therefore be thought, that this likewiſe is meerly Accidental; that in order to prevent the ſame, there lies in the Meſentery G G, (*Tab.* I. *Fig.* 6.) beſides the Blood Veſſels I I, and the Nerves, *m m m* which paſs thro' it, another kind of very narrow Veſſels *l l*, which, when a Creature has continued long without Eating, are quite inviſible, but if you diſſect them a few Hours after it has been fed, they appear as little Veins full of a white Matter like Milk; from whence it is alſo, that they take the Name of *Milky Veins* (*Venæ Lacteæ*;) theſe little Tubes open into the Inteſtines L L, which by their Contracting and Protruſive Motions, do ſqueeze out the thinneſt of the Food, or prepared Chyle, in theſe Milky Veins, under the Form of a White Subſtance; which (in Dogs, according to this Figure borrowed from *Verheyen*) takes its way, firſt towards a great Gland K; but in Men, by ſeveral other ſmaller Glands; ſince, according to the ſaid *Verheyen*, this great Gland is not found in them? Thoſe that deſire to ſee the Deſcription of the Meſentery in a Man, may be pleas'd to conſult the 18*th Table* of the ſaid Author, where the Glands are repreſented by the Letters *a a* in the 2*d Fig.*

We

We ſhall ſay nothing of theſe Glands, becauſe Anatomiſts are not as yet entirely agreed about the Uſe of them; only 'tis known that this Chyle is diſcharged into a large Receptacle O, by the *Venæ Lacteæ* (*Tab.* I. *Fig.* 6.) coming from this Gland: The Anatomiſts call it *Receptaculum Chyli*, or *Ciſterna*.

SECT. III. *The Receptacle of the Chyle in Humane Creatures.*

IT muſt be remembred, that in this Figure the Courſe of the Veſſels is repreſented as it appeared in Dogs, foraſmuch as they are ſeldom to be ſhewn in Men, who cannot be ſo ſoon open'd after their Death. However, they that deſire to ſee a true Deſcription of theſe Parts, as they lie in Humane Bodies, may find them in the *Leipſick Tranſactions*, *p.* 57. *Anno* 1699. extracted from an *Engliſh* Book of *W. Cooper*, conſiſting particularly in the following Differences: 1. That the great Receptacle of the Chyle, repreſented here by the Letter O, is compoſed in Men of three large Tubes and Parts. 2. That the Links of the Chains that are here deſcribed at S, (in the Tube O *s*, which runs upwards, and is called the *Ductus Chylicus*, or *Thoracicus*,) are obſerved to be more numerous or various in Men. *Rohault* does likewiſe make mention of one that is found in a Man.

SECT. IV. *The Courſe of the Chyle to the Heart.*

To return: In this Receptacle O, the aforemention'd Food mixes itſelf with another Humour, Water, or Whey, which the Anatomiſts call the *Lympha*; and which having performed its Service to the Body, is continually derived this Way by the *Vaſa Lymphatica*, or Water-Veſſels; and then this

this *Chyle* and *Lympha* purſue their Way together upwards thro' the Belly and Breaſt along the Back-Bone, from the Receptacle of the Chyle O, thro' the *Ductus Chyliferus r r*; and finally are diſcharged at *u*, in the *Vena Subclavia u x*.

The Blood running from *u* to *x* in the ſaid *Subclavia*, goes from thence thro' *x* B, called the *Vena Cava*, or Hollow Vein, to the Heart A; from whence the *Chyle* and *Lympha* being mingled with the Blood in *u*, are carried round with its Stream throughout the whole Body, in order to the Nouriſhment thereof.

Now can any one ſuppoſe, that the Structure and Diſpoſition of ſo many Veſſels, ſuch as the *Venæ Lacteæ l l*, the *Receptaculum Chyli* O, and its *Ductus r r*, are produced by Chance? Can it be without Deſign, that the *Vaſa Lymphatica q q* and *t t*, do diſcharge themſelves in the two laſt mentioned Receptacle and Duct, to make a perpetual Stream in order to convey the Chyle with greater Conveniency to the Blood in the Vein *u x*? Of all which, if any thing fails or is deficient, a Man runs the Riſque of loſing his precious Life. Is it without Wiſdom that the Creator is pleaſed to divide the Receptacle of the Chyle O, into three Tubes in Men, which in Dogs and other Creatures is but one large one? To the end that in Men, who walk erect, the great Quantity of the Liquor ſhould not eaſily burſt the Membrane that compoſes the Receptacle O, and which is unconceivably thin and fine.

If all this be not yet ſufficient to convince any one, let him attend to that which follows concerning the *Valves*, which will lead him as it were by the Hand to an Almighty and All-wiſe Creator.

SECT.

Sect. V. *The Valves in the* Ductus Chyliferus, Venæ Lacteæ, *and* Vaſa Lymphatica.

Can we not again viſibly obſerve a fix'd Purpoſe and Deſign of bringing the Chyle to the Blood and Heart? Which otherwiſe, together with the *Lympha* in the *Ductus Chyliferus r r*, (*Tab.* I. *Fig.* 6.) ought naturally to deſcend, by reaſon of the erect Poſture of Men: To prevent which, it is moſt wonderfully provided by the Great Creator, that there ſhould be *Valves* in the ſaid Tube or *Ductus*, which are opened by the Chyle when it proceeds upwards from O to *u*, and ſo takes its right Courſe, but are ſhut by the ſame, if it ſhould attempt to go backwards and deſcend; juſt as we ſee in the Gates of Sluices, which, as the Water comes one Way, are open'd without Trouble, but ſhut of themſelves on the other Side, by the Flux of Water againſt them.

And there being a Danger that the Liquor in the *Venæ Lacteæ l l*, and in the *Lymphatica q q*, ſhould deſcend and go backwards by its own Weight, the like kind of Sluices or Flood-Gates are placed in both of 'em.

Among the Lymphatic Veſſels, the *Ductus Chyliferus* itſelf, *r r*, muſt be reckoned, ſince it is likewiſe continually full of this Water, or *Lympha*, when there is no Chyle mingled with it; and ſince, as we have ſaid before, it has alſo its Valves, the Figure of which may be ſeen in ſome meaſure in *Tab.* II. *Fig.* 2. at *c c* and *c c*, and which are in like manner opened by the Liquor that runs from *a* to *d*: But if the ſame Liquor ſhould run backwards from *d* to *a*, they would be cloſed thereby.

Sect.

Sect. VI. *The Protruſion of the Chyle.*

Now if it be further obſerved, that this Veſſel is exceeding tender, for which reaſon it is likewiſe guarded by the *Pleura*, or Membrane of the Ribs; that it has no ſufficient Fibres for protruding the Liquor contained in it when neceſſary (which Fibres do for this Purpoſe abound in the Inteſtines and Arteries) but that nevertheleſs the Proceſs of this Liquor is ſo neceſſary towards the Preſervation of our Lives, that they could not continue without it; ought we not again to ſtand amazed at the Wiſdom of the great Creator, who in this Caſe has been pleaſed to uſe a ſingular Method to drive this Liquor upwards, cauſing for that Purpoſe the great Artery C, (*Tab.* I. *Fig.* 6.) to run along the ſame; placing the *Intercoſtalis c c c*, as alſo the Artery of the Reins D, above and acroſs the ſame, which ſwelling at every Pulſe of the intruded Blood, do as often preſs upon this Tube; and the Liquor thereof being hindered by the Valves from going backwards, muſt neceſſarily move forwards and upwards; to which likewiſe the Tendons of the Midriff, which are drawn up in Breathing, and which alſo preſs upon this Tube, do ſeem very much to contribute?

Is it not now very plain, the Motion being performed after this manner, how neceſſary theſe Valves are; ſince without 'em the Preſſure might as well force the Liquor downwards as upwards? It does likewiſe appear, why they are placed ſo cloſe to each other, and are more numerous here than in the Veins, *viz.* That the Liquor ſhould be immediately ſtopp'd as it endeavours to return; whereas otherwiſe, if the Tube between the two Valves ſhould be very long, it might cauſe it to

ſwell ſo much, by reaſon of its Tenderneſs and Length, that there would be not only a Danger of burſting, but the Motion or Courſe of the Liquor would likewiſe become too ſlow.

Sect. VII. *The Valve in the* Vena Subclavia.

Here is yet another Inſtance of the wonderful Wiſdom of Divine Providence, tho' it ſeems to be but a ſmall Matter; namely, that this *Ductus Chyliferus r r*, diſcharging its Liquor at *u*, into the Subclavian Vein *x*, is covered at its Orifice with a little Membranous Valve in the Shape of a Half-Moon; which does hinder, in the firſt place, the Blood from deſcending from the Vein *u x* into this *Ductus Thoracicus r r*, and ſecondly, is the Cauſe that this little Membrane, being only open exactly on the Side *x*, the Way that the Blood runs, the Chyle coming out of it is thereby immediately carried along with the Stream thereof; whereas, if it had been open on the other Side, the Blood by its ſtrong Circulation would preſs into this Veſſel *r r*, and ſo hindering the Chyle from going forwards, would put an end to our Life.

I cannot forbear repreſenting this laſt Matter in *Tab.* II. *Fig.* 2. which is borrowed from the Accurate Dr. *Lower*: *d b* and *c a* is the *Ductus Chyliferus*, *c c* the Valves, which are here more viſible, becauſe the Chyle being ſqueezed backwards with the Finger from *d* to *b*, againſt the ſaid Valves, makes the Tube ſwell in that Part, leaving the other *b d h* empty. But that which is moſt remarkable in this Figure, is the little Semilunar Valve *i*, which covers the Orifice *h* of the *Ductus Chyliferus* in the *Vena Subclavia*, after ſuch a manner, that the Blood flowing from *f* to *g*, and ſo on to the Heart, is hinder'd from forcing

forcing its Way into the Chyle-Veſſel *d a*, and yet admits of a free Paſſage for the Chyle and *Lympha*, as they run from *a* to *b*: *e* is the Jugular Vein, the Blood of which deſcending into the Vein *f g*, renders this little Valve *i* ſo much the more neceſſary.

SECT. VIII. *Convictions from the foregoing Obſervations.*

Is there then occaſion for any farther Proof of the adorable Wiſdom of the Creator, than what has been juſt now produced? And can any Man be ſo far miſtaken as to attribute all this to Chance, or ignorant Cauſes? For if each of theſe things were not made for that very End of carrying the Chyle and *Lympha* up to the Blood, and thereby preſerving the Life of a Man, why are the little Valves placed there? Why are they all open on the ſame Side? Inſomuch, that if among the great Number of them any one ſhould fail in performing its Work, there would preſently be an End of Life. Once again: If any one ſuppoſes that all this depends upon Chance, why does he not think the ſame of the Sluice-Gates for Water-Mills or other Uſes? For I cannot believe that any one would dare to affirm the ſame of a common Sluice (which nevertheleſs has only the Structure of but two of theſe Valves) that it was made without Knowledge or Skill; to ſay nothing of the amazing Structure of ſuch an innumerable Company of Sluices following one another, and adapted to one and the ſame Purpoſe, as in the Caſe of theſe Tubes.

After all this, if a Man ſeriouſly reflects, that upon the Structure of ſo tender a Veſſel as the *Ductus Chyliferus a d*, (*Tab.* II. *Fig.* 2.) upon the Diſorder of ſo ſmall and not leſs tender Valves *c c*; upon the Inflection towards the wrong Side of

theſe Valves, which are compoſed only of a thin, moiſt and flabby little Membrane; eſpecially upon ſuch a little worthleſs Inſtrument as the Valve *i* appears to be (which covers the Orifice *h* of the *Ductus Chyliferus*, where it is inſerted in the Vein *f g*;) and laſtly, upon the Diſorder not only of all theſe together, but of any one of theſe ſo ſmall and ſeemingly contemptible Particles, our precious Lives are entirely depending; and if but one of 'em all ſhould fail to perform its Function, ſo valuable a Creature as Man is, would preſently turn to a putrifying Carcaſs: Muſt not every one confeſs, that *he is formed after a moſt fearful and wonderful Manner?* And ought we not daily to worſhip our Great Preſerver with the moſt grateful Acknowledgments, for his having vouchſafed to preſerve ſuch fine and ſuch delicate Parts of the Body, all of them abſolutely neceſſary to Life, ſo long and in ſo good a State and Condition? So that the *Pſalmiſt* of *Iſrael* had great Cauſe to ſay, *Pſal.* 139. *v.* 14. *I will praiſe thee, for I am fearfully and wonderfully made; marvellous are thy Works, and that my Soul knoweth right well.*

How often do Clocks, Mills, and other moving Machines ſtand in need of being adjuſted by a skilful Maſter? And ought not this to teach every one, that a great Director does ſupport and maintain all theſe things in that neceſſary State, towards which all Creatures, all the moſt skilful Phyſicians, all the moſt learned Philoſophers, or the moſt ingenious Artificers, cannot contribute the leaſt in the World? And how can any Man forbear charging himſelf with the utmoſt Unreaſonableneſs, who ſeeing ſo great and important a Work, as is the Life of Men and all other Creatures, carried on by ſo ſimple, and, in Appearance, contemptible Means, does nevertheleſs perſiſt in aſcribing it all to meer Chance, or ignorant Cauſes?

Cauſes? And being ſenſible how much Good is thereby daily produced in himſelf, (concerning which he is forced to own, that he not only gave no Direction, but, which is more, that he had not the leaſt Perception;) muſt he not pronounce himſelf both ungrateful and worthy of Condemnation, as often as he refuſes to acknowledge the Mercy and Goodneſs of his Benefactor, and even his Wiſdom alſo, in the midſt of ſo many Wonders.

CONTEMPLATION VI.

Of the Heart.

Sect. I. *The General Uſe of the Heart.*

LET us now go on, and trace the Chyle or Food (which, as we have juſt now ſhew'd, is mingled with the Blood at the left Subclavian) quite to the Heart; in the Structure of which there do occur ſo many wonderful Things, that one would imagine that none but a very unhappy or obſtinate Perſon, ſeeing and comprehending the Compoſition of this Organ, could help being convinced of the Wiſdom of the Great Creator, and of the determinate End to which it is adapted, *viz.* the Reception and Expulſion of the Blood, (whether there be other Uſes of the Heart, I ſhall not here enquire) to the end, that the Blood, by this Motion, having perfected its Circulation thro' the Lungs, and thro' other Veſſels, to all the Parts of the Body, and performed ſeveral other Functions in other Places,

might return to the Beginning of its Courſe, that is, to the Heart and Lungs.

SECT. II. *The Deſcription of the Heart.*

THIS Heart has two Cavities, or Ventricles, ſeparated from each other by a thick fleſhy Wall, or *Septum*, which every one may ſee, that will take the trouble to cut acroſs the Heart of an Ox or Sheep. The Heart, at the upper Part of it A, (*Tab.* II. *Fig.* 3.) is thick, but at the lower Part B, much ſlenderer; the Shape of it is like that of an inverted blunt Pyramid; it is faſtened, and hangs by its Veins and Arteries E F G H I; E is the *Vena Cava*, or hollow Vein by which the Blood deſcends; G is the *Vena Arterioſa*, or *Arteria Pulmonaria*, (the Pulmonic Artery) thro' which it paſſes out of this Ventricle into the Lungs; and H is the *Arteria Venoſa*, or *Vena Pulmonaria* (the Pulmonic Vein) thro' which the ſame Blood returns from the Lungs into the left Ventricle of the Heart; out of which it is carried by the *Aorta*, or great Artery I, to all the Parts of the Body; C is the Right Auricle of the Heart, into which the Blood paſſes from E and F, before it falls into the Right Ventricle; D is the Left Auricle, which performs the ſame Function to the Left Ventricle; K K are the *Arteriæ Coronariæ*, and the *Venæ Coronariæ*, which feed the Heart, and provide it with Blood.

SECT. III. *The Eminence or Protuberance in the* Vena Cava.

BUT here the Stream of Blood deſcending from the *Vena Cava* at E, meeting with another Stream aſcending at F, ſeems to threaten the apparent Danger of theſe two Currents ruſhing againſt each other,

other, either within the Ventricle or Auricle of the Heart; for that Blood which comes down from E, aſſiſted with its own Weight, and having therefore a greater Strength, might hinder the other, which coming up from F, runs againſt it, from purſuing its Courſe; and ſo the Circulation of the Blood, and therewith the Life itſelf, might ſoon come to an End.

Now to prevent theſe Inconveniences, that would otherwiſe be ſo dangerous, we find that between theſe two Veins E and F, (both which are repreſented at A A, *Tab.* II. *Fig.* 4. where they are laid open) there is a Protuberance B, compoſed of the Fat that lies under, againſt which the Blood deſcending from E, runs or ſtrikes, and by that means the Courſe of it is turned to the Right Auricle of the Heart; whilſt the Blood aſcending from F, is by the ſaid Protuberance B covered and ſecured againſt the oppoſite Courſe of the deſcending Blood, and ſo is obliged to turn its Courſe aſide to the Ventricle of the Heart.

We muſt likewiſe here obſerve, that this Protuberance B is much greater in a Man (becauſe in conſequence of his erect Poſture, the upper Blood at E deſcends exactly Perpendicular) than it is in Dogs, Horſes, Cattle, and the like Creatures, in which the Courſe of the Blood at E F is only Horizontal, and therefore does not move with ſo great Force.

Once again: How very *wonderfully* are we made? And can any body ſee, without terrible Emotions, that as our precious Life in the *Ductus Chyliferus*, does entirely depend upon ſuch ſlender and minute Valves, ſo it does here upon ſuch a ſmall Protuberance as is deſcribed at B? If here were no expreſs Deſign of the adorable Creator, why do we find it juſt in this Place? Why is it bigger in a Man, where there is a Neceſſity in

Nature for its being ſo, to balance the Force of the deſcending Blood; and leſs in ſuch Creatures where ſuch Balance is not wanting to perform the ſame Service?

Sect. IV. *The Auricles of the Heart.*

Furthermore, the Courſe of the Blood, which continually paſſes thro' theſe Veins A A, ſeems to require, beſides the Heart, another Reſting-place to be contained in, during the Time in which the Heart contracts itſelf in order to diſcharge the Blood, and while the Valves of the Orifice of the Right Ventricle are ſhut; to the end that it might be there collected in the mean time, and as ſoon as the little Valves are again open, be ſwiftly emptied into the Heart; for which Purpoſe the Auricle C, (*Tab.* II. *Fig.* 3.) ſerves on the right Side of the Heart, as D does on the left, which whilſt the Paſſage thro' the Valves is ſtopt, are full of the Blood that runs into them, and are provided, after a wonderful manner, with Muſcles and other Inſtruments, by which means each of them can ſwiftly contract it ſelf as there is Occaſion, and loſe no time in the ſudden Diſcharge of the Blood into the Right and Left Ventricles of the Heart.

Sect. V. *The Operation of the Heart.*

The Blood being now come thither at the time when the Heart does as it were looſen and open itſelf (I do not here diſpute whether there be a Faculty in the Heart required for that Purpoſe) it contracts itſelf ſuddenly, and with great Force; inſomuch, that the Sides of the Right Ventricle approaching each other by ſuch a Contraction, and the upper and lower Ends thereof being

ing likewiſe drawn together, the whole Cavity is in a manner cloſed, and the Blood thereupon driven out with great Swiftneſs into the Lungs thro' the Pulmonic Artery, or *Vena Arteriosa* G, (*Tab.* II. *Fig.* 3.) and goes onward thro' the Pulmonic Vein, or *Arteria Venoſa* H, to the Left Ventricle of the Heart, after it has been diſtributed thro' the Lungs.

One may have a groſs Conception of this Working of the Heart, by comparing it to a Bellows full of Water, in which there are two round Holes at Top; the one of which, upon the Cloſing or Contraction of the Bellows, is ſtopt with a Valve, whilſt the other remains open; now, in caſe you ſhould with a ſudden and violent Motion preſs the Sides thereof together, ſo that in a Moment, or in the time of one Pulſe, the whole Cavity thereof were taken away, it can ſcarce be imagined with how great Swiftneſs the Water in the Bellows would ſpring out of the Orifice which remains open: And this is a rough Idea of the Manner in which the Blood is ſuddenly extruded from the Right Ventricle of the Heart into the Lungs.

Sect. VI. *The Courſe of the Muſcular Fibres.*

Now, in order to perform this ſo ſudden and violent Contraction, or Syſtole of the Heart, the Muſcular Fibres of which it is compoſed are ſo wonderfully and ſo peculiarly adapted to this very End, that he who is not wilfully Blind, and under a deplorable Hardneſs, muſt herein neceſſarily diſcover the Hand of a Wiſe and Deſigning Creator. That this is not ſaid without good Grounds, will appear plainly enough, to ſuch as pleaſe carefully to conſider the Courſe of theſe Fibres.

For

For you may ſee firſt, the Fibres A and B, (*Tab.* II. *Fig.* 5.) running obliquely from Top to Bottom, and others deſcribed by C and D, croſſing the former; both theſe oblique Fibres being contracted in their Operation, the Cavities of the Heart muſt become narrower, and both its Ends in ſome ſort likewiſe drawn together. Beſides theſe, there are other Fibres that lie above them, and run ſtreight upwards, (*Tab.* II. *Fig.* 6.) which only belong to the Right Ventricle, and by contracting themſelves, do ſhorten the ſame. But the Courſe of the Fibres, that perform the ſame Work in the Left Ventricle, is wonderfully ſurpriſing; for thoſe A B, (*Tab.* II. *Fig.* 7.) running on all ſides from Top to Bottom, encompaſs the Heart at the Point C, and being contracted, draw the ſame upwards towards A: Theſe Fibres are repreſented upon the ſaid Point or ſharp End, as you may ſee *Tab.* II. *Fig.* 8.

Now, in order to aſſiſt the lateral Contraction of the oblique Fibres, we may obſerve a row of other Fibres, A C B, (*Tab.* II. *Fig.* 9.) running under the oblique ones, which perform their Function, by encompaſſing the Heart croſs-wiſe, and contracting the ſame; ſo that here is in a manner the like Diſproportion of Muſcles as has been ſhewn above, in deſcribing thoſe of the Belly: This whole Matter is largely treated of in that little, but accurate, Diſcourſe of the Learned Dr. *Lower*.

Let any Body now that underſtands theſe Things, ſeriouſly conſider with himſelf, whether it be poſſible, that ſuch a variety of Rows of Fibres, endowed with ſuch a great Strength together (as has been demonſtrated by *Borelli*) and all ſerving to that very Purpoſe, for which the Heart ſeems alone to have been form'd, that is to ſay, by its Contraction, to protrude the Blood it has received into the Arteries joyn'd to it; I ſay, whether all

thoſe Fibres can have acquired this wonderful Diſpoſition, without Wiſdom and without Deſign?

Now, ſince there are not hitherto any other Muſcles diſcover'd in the whole Heart, ſave thoſe that contract it and render its Cavities narrower; is this likewiſe by Chance, that the Fibres thereof when once Contracted, are not ſuffer'd to continue in the ſame Condition, but preſently dilating themſelves do open the Cavities, that they may again receive the following Blood out of the Veins, and by the repeated Contraction of the Heart, diſtribute it to the Lungs and other Parts continually, and as long as our Lives do laſt?

Sect. VII. *The Action of the Valves of the Veins.*

There ſtill remains another Difficulty in the Uſe of the Heart, *viz.* that (ſince each Ventricle has two Orifices, one by which the Blood enters, and the other, by which it goes out again) it ſeems to be a Conſequence thereof, that the Heart being ſo ſuddenly and ſtrongly Contracted, the Blood ſhould flow at once out of both of 'em, and ſo be forced backwards by the ſame Paſſage by which it enter'd into this Ventricle.

To prevent the ſame, the wiſe Power of the wonderful Creator does again appear, who for this Purpoſe has been pleaſed to place there another ſort of Valves (which, by reaſon of their Triangular Figure, the Anatomiſts call *Mytrales*, becauſe they repreſent a Biſhop's Mitre) that part of both the Veins, thro' which the Blood is diſcharged into the Heart; and theſe, when the Heart contracts it ſelf, and the Blood is thereby driven towards the Orifice, in the Circumference whereof they are placed, are thereby ſhut very cloſely: Theſe Valves (which we can hardly look upon without Amazement, if we conſider the Providential

tial Views of the Creator) are faſten'd to the ſides of the Ventricles with a great many tendinous Fibres, that are very Strong, in order to ſecure the Valves when they are ſhut, like ſo many Bars and Chains upon Doors, to the end that the Force wherewith the Blood that was ſqueezed out of the Ventricles acting againſt them, may not break them open, or bend them in ſuch Manner on the other ſide, as to make a Paſſage thro' them for the Blood; eſpecially, conſidering that they are compoſed only of thin and flexible Membranes, and not of Bones or other ſolid Matter.

Theſe Tendinous Fibres, have moreover the following remarkable Uſes: *Firſt*, That as the Heart after its Contraction, does again dilate it ſelf and become longer, and conſequently the Sides of it, which were raiſed upwards, do ſink down again; I ſay, the ſaid Fibres being faſten'd to the Sides, draw the Valves open (as is done in the Gates of ſome Sluices with Ropes) in order to make a free Paſſage for the returning Blood. *Secondly*, That theſe Fibres are faſten'd in ſuch a manner to ſome little Protuberances, or Pins of the Sides of the Heart, and even to the oppoſite Side alſo, that they can hinder thoſe Valves from falling down flat, or from touching the Sides of the Heart, to the end that the Blood, in the Contraction of the Ventricle, may preſs againſt theſe Valves continually from below, and ſo raiſe them upwards, in order to cloſe their Orifices.

Sect. VIII. *Convictions from the foregoing Obſervations.*

I Have given an Account of the chiefeſt of theſe Matters by Words only, without adding any Figures to them; having found in the moſt accurate Books of Anatomy, that the beſt and moſt exact

exact Figures taken from the Original, are not capable of giving much Light, by reaſon of the vaſt Number of Particulars that are obſervable therein, to ſuch as have not viewed the ſame in the Heart of any Creature; for they would require more Study and Application to be underſtood, than even the Structure of the Heart itſelf. They that would make a Tryal thereof, may conſult the *Fourth Figure* in the *14th Table* of Monſieur *Verheyen*, and the *Firſt Figure* in the *5th Table* of Dr. *Lower*.

Farther, if there were any known Machine to be met with, the Operarions whereof had any Analogy or Similitude with thoſe of the Heart, the Deſcription of it might, perhaps, render this Account a little clearer; but neither Pumps, nor any kinds of Spouts, no, not even the Modern Engines for quenching Fires (tho' in the opening or ſhutting of their Valves, they may ſeem in ſome manner to imitate the Heart) nor any thing elſe that Art has yet been able to produce, can any-wiſe come near them, to repreſent the great Wiſdom wherewith this wonderful Machine of the Heart is formed. Can any Man then imagine, that this great Work has been made by Chance; when no Body dares affirm the ſame, even of all thoſe other Imperfect Machines that have been mention'd above?

Having oftentimes meditated upon theſe Things, I have thought with my ſelf, *how fearfully and wonderfully we were made*, as upon two other occaſions has been mention'd before; for in caſe one of theſe Valves ſhould be out of order, and unfit to perform its Function; yea, if one of theſe little Fibres, which are faſten'd to the Valve and draw it up, ſhould break, or be either too ſhort or too long, theſe little Sluice-Gates could not be ſhut, as not being able to come upon each other, if the Fibres

bres were too ſhort; or, if too long, not able to remain ſo, but forced to give way to the Preſſure of the Blood; inſomuch, that not only upon each of theſe little Valves, but, which is yet more amazing, upon the various Length of theſe fine Fibres, the Life of ſo Artful a Machine as every Man is, yea, even the Lives of Kings and Princes themſelves, and of all Creatures whatſoever, do entirely depend.

Sect. IX. *The Valves of the Arteries.*

This being ſaid of the Orifices, thro' which the Blood paſſes into both the Ventricles of the Heart, there was yet danger, that when the Blood was protruded from the Right Ventricle into the Artery of the Lungs, and out of the Left into the Great Artery, the Heart opening itſelf again, and the Expulſive Force ceaſing with the *Syſtole*, the Blood by its Weight might go back into the Ventricle of the Heart from whence it came, and ſo, by obſtructing the Circulation, cauſe immediate Death.

But here the Care of a moſt merciful Creator has interpoſed, by placing other Valves again at the beginning of both theſe Arteries, which perform juſt the contrary Function to the foregoing; ſo, that as the former were ſhut by the Blood that endeavour'd to aſcend from the Heart, theſe are ſhut by that which deſcended to the Heart: And, whereas the firſt were open'd by the Blood that ran to them, the ſame is effected in theſe, by the Blood that iſſues out.

That this may be more clearly conceived, let (*Tab.* II. *Fig.* 10.) *a a* repreſent the open'd Part of the Left Ventricle of the Heart; *c* the Great Artery diſſected lengthwiſe; *b b b*, the three Semi-lunar Valves, which are ſhut by the returning Blood:

Here

Here they appear lying flat and extended, whereas, otherwiſe they fill the round Orifices of the Artery; *ff* are the three Triangular, or Mitral Valves turned aſide, that you may ſee the other *bbb*, the better; and at thoſe *ff*, one may obſerve the Fibres *fg* ſtill hanging, the Ends of which *gg*, are ſhewn cut off from the ſides of the Heart, to which they are otherwiſe faſten'd, when in their Natural State.

How theſe little Valves *bbb*, are diſpoſed by the Blood that is driven back, and how they ſhut the Artery, may be obſerv'd *ccc* (*Tab.* II. *Fig* 2.) The Appearance is likewiſe the ſame, if you blow into the Artery A; B B are the Crown-Arteries (*Arteriæ Coronariæ*) which feed the Heart, and carry their Blood thither; the Openings of which into the *Aorta*, or Great Artery, are repreſented in (*Tab.* II. *Fig.* 10.) *d d*, exactly above theſe Valves.

Sect. X. *The Lateral Muſcles of the Heart.*

All the admirable Curioſities obſervable in the Heart, would be too many to be here nicely examined into. The Lateral Muſcles in the Right Ventricle of the Heart (to paſs by a great many other wonderful Contrivances in that Organ) ſeem here to require more particularly an immediate Attention; theſe Muſcles, holding the Sides of the Heart together, hinder it from being too much extended by the Blood that falls into it at each Diaſtole, and ſo ſerve for a Meaſure of the Quantity that is to be poured into it at each time; they do likewiſe contribute to the bringing the Sides nearer together in the *Syſtole* or Contraction of the Heart. Thus, we likewiſe perceive, that the left Ventricle is encompaſſed with much ſtronger Muſcles and Walls than the Right, which appears when you cut

cut the Heart a-croſs; becauſe, that this laſt is only to convey the Blood thro' the Lungs, which bears no Compariſon with the Diſtance (*viz.* the extreme Parts of the Body) which it arrives at by the force of the Left Ventricle of the Heart. Whether this Force be wholly determin'd by the Contracting Muſcles of the Left Ventricle; or whether the Arteries afford any co-operating Power towards this Motion of the Blood, is yet a Matter in diſpute: But this is certain, that whatever Force conveys the Blood to the Extremities of the Body, contributes towards furniſhing it there with the Means of returning to the Heart by the Veins. If People cannot here diſcover the Views and Deſigns of their Great Creator, their Blindneſs is much to be lamented: Yea, ought not every one to ſtand amazed, that ſees ſo much Swiftneſs communicated to the Blood, by ſuch a ſoft fleſhy Inſtrument, in order to perform ſo great a Circulation in ſo ſhort a time?

Sect. XI. *The Force and Power of the Heart, repreſented by Compariſons.*

He that doubts whether the Syſtole of the Heart is a Force ſufficient of it ſelf to bring about ſuch a Circulation, may, without Mathematicks, obſerve how great a Force and Swiftneſs is performed by the Compreſſion of two Bodies, by taking a Cherry-Stone, and ſuddenly ſqueezing it between his Fore-finger and Thumb, which will cauſe it to fly out more ſwiftly than a Perſon never making that Obſervation cou'd eaſily imagine: By taking a Hand full of wet Clay, and compreſſing it ſuddenly, as the Heart does the Blood, another notable Inſtance offers it ſelf; for, by obſerving how nimbly the Clay burſts out, wherever there is a Paſſage for it between the Fingers;

gers; and, conſidering at the ſame time, that this Clay has five Places to come out at (three between the Fingers, one at the Top, and another at the Bottom of the Hand) this Concluſion (which illuſtrates the Motion of the Blood from the Heart) naturally reſults; *viz.* that if the Clay iſſued out only through one Paſſage (inſtead of five) the Velocity wou'd be five Times greater. After the ſame manner the Spittle, which is produced in the Mouth by Smoaking Tobacco, is diſcharg'd with great Swiftneſs; this is perform'd by collecting the Moiſture into a Cavity between the Tongue and Lips, which Cavity they afterwards deſtroy, by thruſting the Tongue againſt the Lips, and ſo force the Spittle out. One might inſtance in other Caſes, but this is ſufficient, to repreſent in ſome ſort, the Purpoſe in hand.

Sect. XII. *The* Pericardium, *or little Bag of the Heart.*

Add To all this, that the Heart is preſerved in a Membraneous Bag, called the *Pericardium*; which, by furniſhing a Liquor from its little Glands (concerning this, ſee *Bergeus*, *Malpighius*, &c.) does continually keep the Heart ſmooth, and fit to perform its conſtant Powerful Motions, hindring its External Membrane from being wrinkled by too much Dryneſs; and it lubricates and moiſtens the adjacent Muſcular Fibres, by which means this wonderful Inſtrument is enabled to perform its neceſſary Functions, which otherwiſe would be obſtructed.

SECT. XIII. *Convictions from the foregoing Obſervations.*

To ſay no more; after the Contemplation of this Heart in all its above-mentioned Circumſtances, can an unhappy Philoſopher, even the moſt ill-natured and obdurate Atheiſt, be eaſy in maintaining, that all this is performed without Wiſdom, without Deſign, and only by ignorant Cauſes? Since he cannot but know, that he would be taken by all Men, and without doubt by himſelf too, for a very fooliſh Perſon, in caſe he durſt affirm, that a Fire-Engine only (which by no means is to be compared with the wiſe Contrivance and Structure of the Heart) was produced by Chance, and without the Concurrence of a skilful Workman. Let him alſo add, that this Machine is made and put into Motion by another, ſo that the whole is performed in his own Body, not only without his Will, but even without his Knowledge and Perception; and will he not yet ſee that his dear and precious Life is ſupported by another, who has ſhewn ſo great Wiſdom therein? How can any one conceive, that this Motion of the Heart, according to the Calculation of the famous Mathematician *Borelli*, muſt be performed by the exerting of more Force at every Pulſe, than is required to ſurmount the Reſiſtance of ſome thouſand Pounds Weight? That ſuch a Motion is performed above two thouſand times in an Hour, without ever ceaſing, whether we wake or ſleep, for the Space of fifty, ſixty, or ſeventy Years perhaps? And particularly ſince our other Muſcles, after much leſs Pains, and ſometimes but in one Day, become ſo tired and impotent, which never happens to the Muſcles of this little Heart in ſo many Years. And cannot then ſo great a Matter, brought

brought about by ſuch wonderful Inſtruments, and after ſo amazing a Manner, convince every Man that is reaſonable, and make him conclude with Certainty, that a Power far exceeding Humane Knowledge is here exerted.

Yea none can deny, that according to what we have juſt now ſhewn, that as often as he lays his Hand upon his Breaſt, and feels his Heart beat, that this Motion is performed without his own Concurrence, and conſequently by that of another.

CONTEMPLATION VII.

Of Reſpiration.

SECT. I. *The Air is neceſſary to the Blood.*

THOSE who have read the preceding Diſcourſes are already informed, that the Blood diſcharges it ſelf from the Veins E and F, *Tab.* II. *Fig.* 3. into the Right Ventricle of the Heart; from thence it is introduced into the Lungs (by the Syſtole of the Right Ventricle) thro' the *Vena Arteriosa*, or Pulmonic Artery G; and from the Lungs it is again diſcharged into the Left Ventricle of the Heart, by the *Arteria Venoſa*, or Pulmonic Vein H.

Now whether the Blood paſſes from one of theſe Tubes into the other immediately, or whether it paſſes thro' that Subſtance of the Lungs which is of the Nature of Bellows, we will not here enquire; this is certain, that the Air ſucked

into the Lungs where this Blood is, does, as long as Life laſts, come in and go out again; and whatever the Uſe of it be, it is ſo great, that no Man can want it a ſhort Space of Time, without preſently dying; and it is no leſs probable, that the Inſtruments by which the Air is conveyed into the Lungs, are made with great Skill and Contrivance.

Sect. II. *The Blood Veſſels and* Aſpera Arteria *in the Lungs.*

He that doubts of this, let him take the Lungs and Wind-Pipe of a Lamb, or any other Animal, in which may be obſerved, 1. That the upper Orifice of the ſaid Wind-Pipe can be covered with a ſmall Cartilage, called the *Epiglottis*, whilſt the Food is deſcending thro' the Gullet that lies behind it, into the Stomach. 2. That whereas the Branches of the Wind-Pipe, which ſpread themſelves into the Lungs, are Cartilaginous, and of a round or Cylindric Figure, that they may always remain open; yet the Wind-Pipe itſelf, where it lies upon the Gullet, that it may not hinder the Paſſage of the Air, in the fore Part of it, does by its Cartilages compoſe part of a circular Figure only, and behind has only a Membranous Covering, becauſe the Cartilages perceivable in the fore Part of the Wind-Pipe, would preſs too hard upon the Gullet, thereby incommoding the Paſſage of the Food. 3. The wonderful Structure of the Air-Tubes, or Branches of the Wind-Pipe, (*Tab.* II. *Fig.* 12. A E) which paſſing throughout the Lungs, lie between the two Blood-Veſſels B E and C E; of which B E ſerves for a Paſſage to the Blood that enters into the Lungs, and C E to that which coming out of the ſame enters into the left Cavity of the Heart. The ſame is obſerved

ſerved to happen conſtantly in theſe Lateral Branches; the Blood-Veſſels being cut off here, they are repreſented finer, and the Ramifications of Air-Veſſels interwoven with them are more commodiouſly deſcribed.

Sect. III. *The Glands in the Wind-Pipe.*

But if it was neceſſary to uſe great Care in the Formation of any Part of the Body, it ſeems to be moſtly ſo here; to the end that this Tube, (which as long as we live, or whether we wake or ſleep, admits of a conſtant Influx and Reflux of Air) ſhould not by this Air grow dry. Is there then no Deſign to be traced and obſerved here? Since the Omniſcient Creator has cloathed the ſame on the inſide, not only with a Glandulous Membrane, from which a Humor is always filtrating; and in order to moiſten the Throat itſelf has been pleaſed to place two Glands called the *Thyroideæ*, of a conſiderable Bigneſs, for that Uſe, beſides thoſe other Glands which we commonly name the *Almonds*; but further, to manifeſt his intended Purpoſe more clearly, has planted in all thoſe Places where the Air-Veſſel is divided into Branches, very viſible Glands for the Moiſture thereof; (whether they have any other Uſes beſides, we are not now enquiring:) And foraſmuch as the *Epiglottis*, by reaſon of the continual paſſing and repaſſing of the Air that ſtrikes upon it, ſeems almoſt impoſſible to be kept moiſtened, and if it were dry, could not ſo well diſcharge its important Function; can any one ſee, without Aſtoniſhment, how the great and wiſe Contriver thereof, has furniſhed this Cartilage with ſo many little Glands above and below, in order to moiſten it beyond all others.

SECT. IV. *A Hundred Muſcles requiſite towards Reſpiration.*

NOT to mention here the Diviſions of the Wind-Pipe into ſo many Cartilaginous Rings, nor the Membranes and Fibres by which they are faſtened to each other, nor the wonderful Structure of the *Larynx*, conſiſting of ſo many Cartilages, and moved by fourteen Muſcles, to the end that by all this *Apparatus*, the Wind-Pipe and its Orifice being ſeveral ways lengthened and ſhortened, dilated and contracted, the Voice might be thereby formed, and yield a more ſhrill or deep Sound; which Things being now become the Object of the Inquiry of ſeveral great Naturaliſts, we ſhall here confine ourſelves only to Reſpiration, and content ourſelves with asking any one that does ſtill Queſtion the Wiſdom of his Creator, whether he can believe that the Inſtruments, which beſides the Lungs are neceſſary thereto, could be ranged and placed near the others without any Underſtanding or Deſign? Eſpecially if it ſhould be proved to him, that altho' the Midriff alone is ſufficient for Reſpiration, yet to the end that ſo neceſſary a Work as this is, might not eaſily be obſtructed, about a hundred different Muſcles are likewiſe applied to the ſame Purpoſe; and, as eaſy as the Action of Breathing may appear to be, that in a ſtrong Reſpiration (when every one of this great Number of Muſcles, that are capable of being uſed therein are employed for the Purpoſe) before the Breath be drawn in and driven out again, this great Number of Muſcles muſt have all been employed for that Purpoſe.

This is ſufficiently known to the Anatomiſts; and, to give you a ſmall Sketch of it here, we ſhall inform you, that in drawing in the Breath, in order

order to raiſe up the Ribs and the Breaſt-Bone, and thereby to dilate the Cavity of the *Thorax*, or Breaſt, there are put in Motion on the one Side, one *Muſculus Subclavius*, eleven *Intercoſtales Externi*, eleven *Levatores Coſtarum*, beſides the *Serratus Anticus Minor*, the *Serratus Anticus Major*, the *Serratus Poſticus Superior*, and the *Cervicalis deſcendens Diemerbroekii*, beſides three others which are therefore called *Common*, becauſe they likewiſe perform other Motions, *viz.* the *Pectoralis*, *Scalenus*, and *Levator Scapulæ*, which together make thirty Muſcles on one Side; and there being as many more on the other, are in the whole ſixty that are alone employed in *Inſpiration*, or drawing our Breath inwards.

Towards *Expiration* there are likewiſe employed nineteen Muſcles of a Side, eleven *Intercoſtales Interni*, the *Triangularis*, the *Sacrolumbus*, and the *Serratus Poſticus Inferior*, and with theſe alſo five *Common* ones, *viz.* the Muſcles of the Belly; theſe are altogether thirty-eight Muſcles, uſed for Expiration only, which being added to the ſixty above, make together the Number of ninety-eight: Now if you add to theſe the Midrif, being the principal Inſtrument of them all, and which, according to the Opinion of that great Anacomiſt *Verheyen*, conſiſts of two, or it may be three Muſcles more, there muſt, according to this Computation, be at leaſt a hundred Muſcles made uſe of in one ſingle Action of Breathing as ſtrongly as we can. Theſe Obſervations we find made in the *Acta Lipſienſia*, *Anno* 1707, of *J. G. Pauli*, upon *Van Horne*.

I would now ask again, whether any Body can ſuppoſe that ſuch a Diſpoſition, where there are ſo many Muſcles conſiſting of Fibres extended ſo many different Ways, is produced by Chance, or without Deſign? Or whether it does not plainly appear to him, that this great Compoſition of

the Muſcles is expreſly adapted to the end of Breathing.

Sect. V. *Without Air this whole Structure is uſeleſs.*

But if what has been here mentioned concerning the Diſpoſition of theſe Muſcles, ſhall appear wonderful in every Man's Eyes, will he not yet ſtand more amazed at the Wiſdom of the great Director of all Things, when he finds that all theſe Inſtruments, tho' never ſo artfully adapted to Reſpiration, would be yet in vain, and of no manner of uſe, if Mankind, and all other Creatures breathing, were not ſurrounded with ſuch a Matter as the Air is, which has in it, among other Properties, an Expanſive Power (*Vis Elaſtica*) beſides a Weight, which cauſes it to operate and dilate itſelf; from whence it comes to paſs, that as ſoon as the Breaſt is enlarged by the Operation of the above-mentioned Muſcles, this Air immediately ruſhes into the Wind-Pipe and Lungs; of which Property (taking it at preſent for granted) we ſhall treat more largely hereafter, when we enter upon the *Contemplation* of the *Air* itſelf; and we ſhall prove experimentally, that in an Air which is but partially diveſted of this *Elaſtic Force*, almoſt all Creatures will immediately periſh.

Sect. VI. *The Properties of Expanded Air.*

However, that we may here give you ſome Idea of Reſpiration, it will be neceſſary to repreſent previouſly, 1. That when the Place in which any Air is ſhut up, is made larger, the ſaid Air filling a greater Space, is ſo much the more weakened in its expanſive Force. 2. If the Air thus weakened has any Communication with other Air that is ſtronger, and both of 'em can act upon each

each other, the ſtronger Air will immediately ruſh into the enlarged Place, in which the weaker was contained.

Sect. VII. *The Compariſon of Reſpiration with a Pair of Bellows.*

To prove this by a Compariſon, one need only repreſent to one's ſelf a Pair of Bellows (*Tab.* III. *Fg.* 1. A E F) in which we know that nothing more is requiſite in order to draw the Air into the Mouth A, or Tube A B, than to ſeparate the Sides E D and F G from each other; by which Means the Space E D G F is inlarged; and ſo the Air that was contained therein being weaken'd, and not powerful enough to ballance the external Air, with which it had a Communication by the Tube A B) the laſt being now become the ſtrongeſt, does by its *Elaſtic* Force crowd itſelf into the Mouth of the Bellows.

The ſame thing would happen, if one ſuppoſed that a Bladder B C were faſtened to the Tube A B within the Bellows; in which Caſe the Space K being dilated, the Air therein would likewiſe be too weak to reſiſt the Air which fills the hollow of the Bladder B C, thro' the Tube A B, by which means this Bladder will be blown up, and expanded by the ſtronger external Air ruſhing in upon it.

Now if you ſuppoſe the Tube A B to be the Wind-Pipe, the Bladder B C the Lungs, and the Space thereof E D G F the Cavity of the *Thorax* or Breaſt, you will ſee the Reaſon why the Air ruſhes thro' the Wind-Pipe into the Lungs, to which it is faſtened like theſe Bellows, when by preſſing down the Midrif, and by the other Muſcles, the Breaſt is made wider and larger.

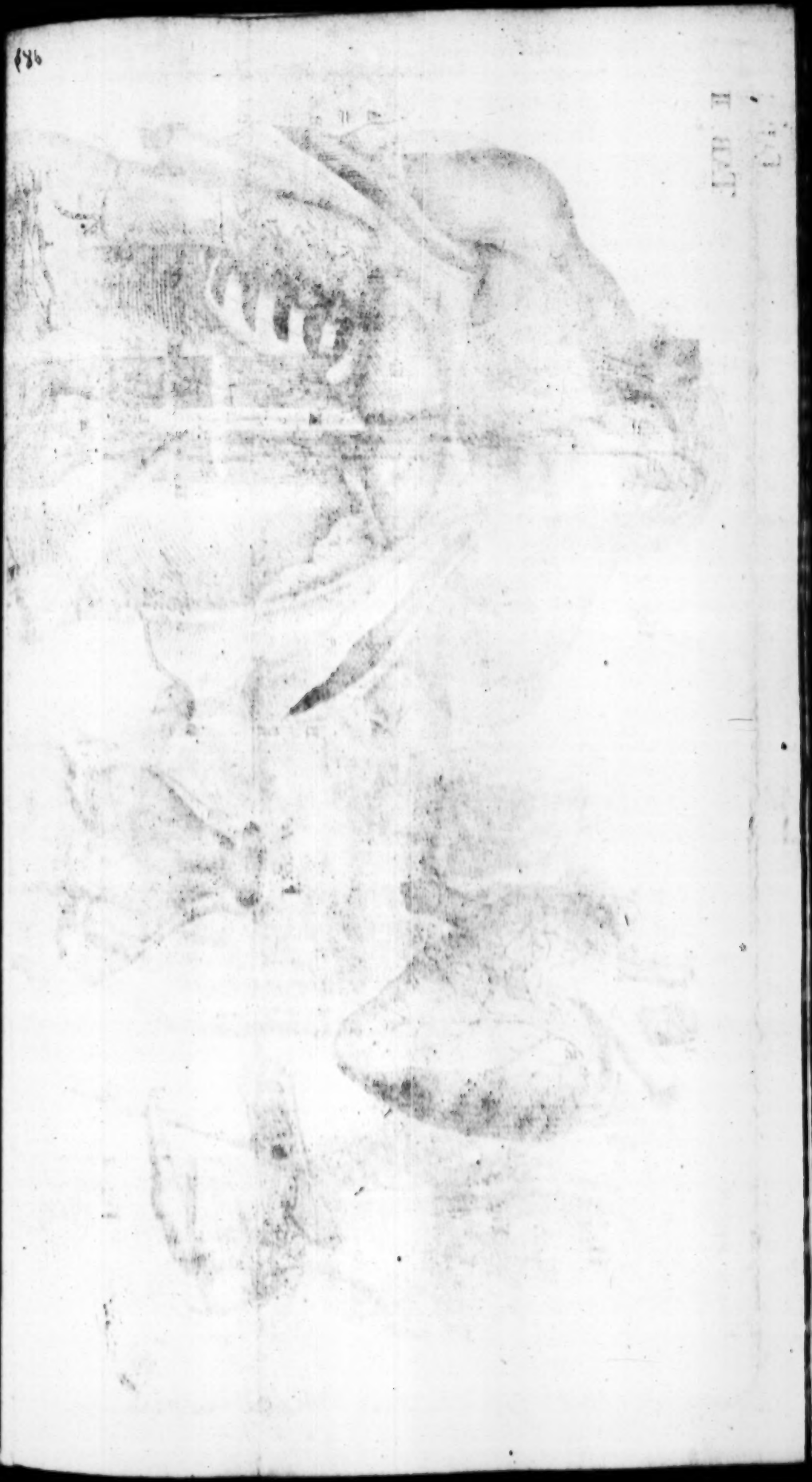
He that deſires farther to ſee how the Lungs, whilſt hanging to the Wind-Pipe, may be puffed up by the Air, need only take the trouble of blowing ſtrongly into the Wind-Pipe of a Sheep or Ox newly killed, by which means he will ſee the Lungs, like a pair of Bellows, expanded by the Wind that paſſes into them.

SECT. VIII. *An Experiment upon the Lungs in Vacuo.*

I HAVE repreſented theſe Appearances after ſuch a groſs Manner, to the end that thoſe who have not the Opportunity of uſing the Air-Pump, may have ſome Conception thereof; but thoſe that have uſed this extraordinary Inſtrument, ſo neceſſary in examining the Works of the great Creator, may form to themſelves a much clearer and more diſtinct Notion thereof.

Let the Covering O P be laid upon the Glaſs O P F *Tab.* III. *Fig.* 2. ſtanding upon the Air-Pump, which has a little Tube A N B paſſing thro' the Centre of it, and a little Cock at N, which now appears open, but may be ſhut; under this Covering, at the Extremity of the little Tube A N, there is another ſcrewed on at B C, the End of which is ſtuck into the Wind Pipe of a little Piece of Lungs D, which is tied faſt to it.

Now when the *Piſton* Sucker L M of the Air-Pump is thruſt to I K, or ſo far inwards as poſſible, one ſees that the Piece of Lungs D hangs in the Space E, that does not extend it ſelf farther than from O P to I K, when the Cock G H is open, in which Space the internal Air is ſhut up; the little Cock at N being turned, the Sucker is drawn backwards from I K to L M; by which means the Space that contained the included Air is ſo much larger, as the Diſtance between I K and L M;



fronting page 86

TAB. II

Fig. 1

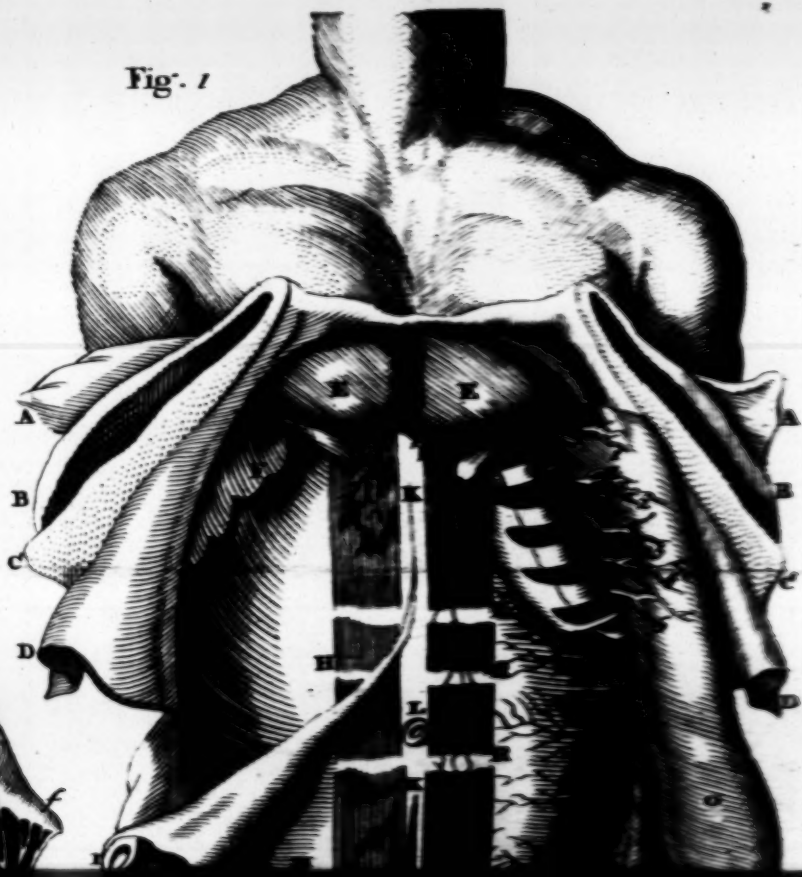


Fig. 3

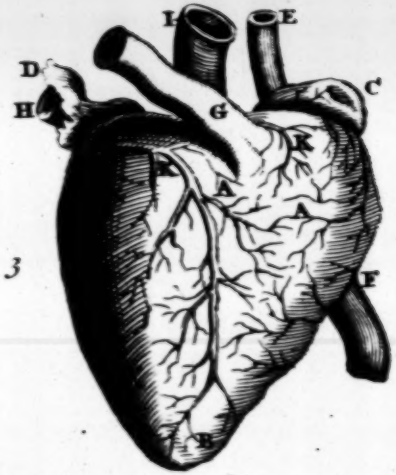


Fig. 2

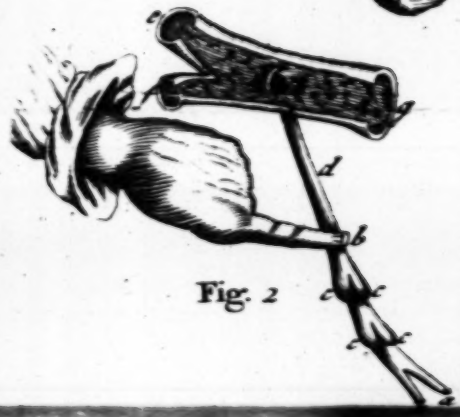


Fig. 10



Fig. 6



Fig. 11





Fig. 12

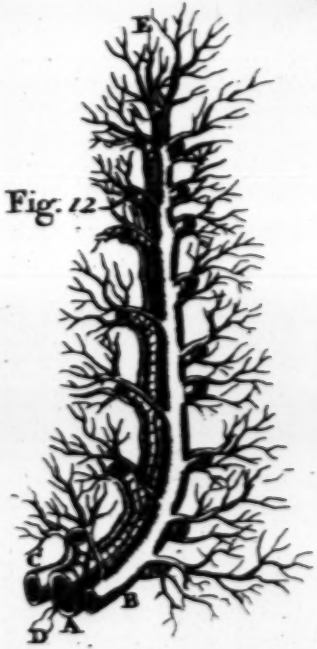




Fig. 4

Fig. 8

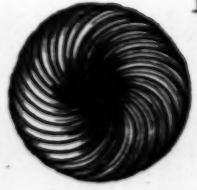


Fig. 7

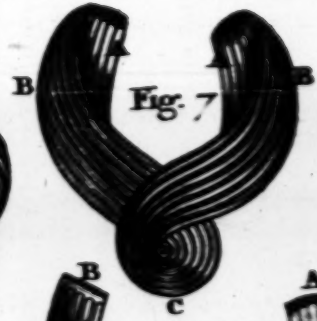


Fig. 5.

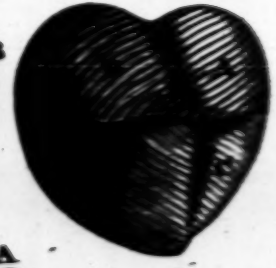


Fig. 9





L M; both Spaces being filled by the Expanſion of the Air, which therefore loſes a great deal of its Elaſticity: This will appear, if you open again the little Cock N, when the external Air ruſhing into the Piece of Lungs D, thro' the Tube A B, blows it up; the Reaſon of which is, that this Air having loſt nothing of its Elaſticity, preſſes more ſtrongly into the Lungs D from without, than the included Air at E, which preſſes it inwardly, is able to reſiſt, becauſe of the weakning of its Spring.

That this is true, will appear, foraſmuch as if you thruſt the Sucker L M forwards to I K, and reduce the included Air into a narrower Space, it will again ſtrongly expand itſelf at E, and preſſing with more Violence the Lungs D, will make them become ſmaller, by forcing the Air which was in them to go out again thro' the Tube B A; and this Effect you may produce as often as you repeat the Experiment, by drawing or thruſting the Sucker backwards or forwards. Now if you will ſuppoſe the Tube A B to be the Wind-Pipe, the Space O P K I to be the Cavity of the *Thorax*, and the Sucker L M the Midrif, there will be a mighty Analogy between that Experiment and the Buſineſs of *Reſpiration*; And the whole Difference is only, that whereas the Cavity of the *Thorax*, in which the Lungs hang, is dilated and contracted by the Muſcles and other Inſtruments; the ſame Effect is produced in the Air-Pump, only by the Sucker thereof.

Now ſuch as don't think it worth the while, or have not the Opportunity of making this Experiment with the Lungs of any little Animal, may make uſe of an empty Bladder D, tying the ſame to the End of the little Tube B C, which will give you all the Appearances very conveniently and agreeably, ſo that with but half a turn of the Handle

Handle of the Air-Pump one way or other, you may fill or empty the Bladder of Air.

Sect. IX. *An Experiment with a little Bottle of Water.*

Now if any Body has a mind to ſee with his own Eyes, after what manner and how violently the Air crowds itſelf into the Lungs as ſoon as the Cavity of the Breaſt is enlarged; inſtead of a piece of Lungs or Bladder, let him take a little Glaſs Viol, holding about an Ounce or ſuch like quantity of Water, and tye it to the Tube B C, ſo that the End of the Tube may be thruſt as far as it can into the Water, then ſhut the Cock N, and enlarge the Space as before, by drawing back the Sucker to L M; let him open the little Cock N, and he will ſee that the External Air, which by its ſtrong expanſive Faculty forced itſelf inwards, will put the Water into a very violent Motion, juſt as if any Body ſhould ſet his Mouth to the other end of the Tube A, and blow thro' the Water as hard as he can.

Sect. X. *The Experiment of a Syringe in* Vacuo.

Now, in order to convince every one Experimentally, that altho' a ſpace be inlarged, as happens in the *Thorax*, when we draw in our Breath, or even, tho' a ſpace be made where there was none before, as in a Syringe, by drawing up the Sucker; there are nevertheleſs caſes, in which, if the Matter that otherwiſe riſes up in the Syringe, has no Expanſive or Elaſtical Parts in it, or is not moved or preſſed after ſome other manner; it will by no means run into the empty Spaces, in order to fill the ſame. Let any one but caſt his Eye upon this little Machine, F H I, (*Tab.* III. Fig.

Fig. 3.) which is commonly to be found in the Shops of thoſe that make Air-Pumps, and he will ſee, that if an empty Space be made in the Syringe A B, by drawing up the Sucker F A, (after having firſt diſcharged the Air at G, out of the Glaſs-Bell A B I, thro' the Air-Pump) the Water in the little Glaſs D E, in which the Tube of the Syringe ſtands B C, and which is open at C, will by no means riſe up into the Tube, nor fill the empty Space in the Syringe, as uſually; becauſe the Water D E, has no ſenſible Elaſticity or Spring in it ſelf, nor is acted upon, by any other Elaſtick Body, which in this Circumſtance would be requiſite; from whence one may conclude, and not obſcurely neither, what we have already ſaid, concerning Reſpiration, *viz.* That altho' there be Space enough prepared in the Breaſt, in order for Breathing, yet, in many Caſes no Air (if, like the Water, it ſhould happen not to be Elaſtick, nor heavy enough) would come in: All which, is yet hereby more evident, that, ſo ſoon as one lets in the Air again into the Glaſs Bell, H I B, the ſame Gravitating upon the Water D E, by its Elaſtick Force, imediately cauſes it to riſe up into the Space that was made for it at A B, thro' the Tube B C, in which, as there is now no Air remaining in it, there is no Reſiſtance.

Sect. XI. *Convictions from the foregoing Obſervations.*

Now let the proud and haughty Creature called *Man*, think once ſeriouſly with himſelf, and ſee whether he can find any Subterfuge, whereby he may avoid owning, that he is obliged, like the meaneſt Beggar, every time he fetches his Breath to repreſent his Poverty to his Maker, and his Inability of preſerving his own Life, but one minute;

and

and to beg him, that he would vouchsafe to fill his empty and gaping Lungs and Breast, with fresh good and wholesome Air, and so continue his Life from one Instant to another: And can any Body contemplate with Attention, this Nothingness of himself, and absolute Dependance at every Breathing, upon his great Preserver, and the so many Thousand, yea Millions of Times, in which this gracious Benefactor has most freely granted him breath, and consequently, his precious Life, during so many Years; and yet remain, not only ungrateful to him, but even deny all his adorable Attributes and Perfections, even those that he has found so Beneficial to himself; and, if it were possible, wish to annihilate the same. What shall be said of such unreasonable and impious Opinions, but that they ought to be detested by all Generous and Grateful Souls?

Sect. XII. *The Use of Respiration.*

We shall not here enquire more largely into the Advantage which this Respiration, (the manner of which we have hitherto treated of) gives to Mankind: Since the most Learned Naturalists are not entirely agreed, whether it serves to cool the Blood; or, whether it be to procure a more convenient Passage for the Air alone thro' the little Tubes of the Lungs, and thereby to produce a better mixture of Blood; or lastly, to communicate a Nitrous Spirit to the same in the Lungs; which is believed by many, because, if the Blood running from a Vein, be mixed with Water impregnated with Salt Peter, it changes its dark Colour into a shining Red, and the *Serum* or Whey thereof, becomes as clear as Water, tho' containing nevertheless, a sufficient quantity of Material Food, as may be observed by putting some drops of the Acid Spirit of *Nitre*, or *Aqua fortis* therein, which will separate a White Curd from

from the ſaid Whey: Now the Arterial Blood has likewiſe the ſame Property, being dark before it comes into the Lungs: but after, having paſſed thro' the ſame, and therein undergone the Action of the Air (be it what it will) diſcovers a bright red Colour, when diſcharged into the Left Ventricle of the Heart, and when it proceeds further into the Arteries: And that which is obſerved by ſome with greater probability, is, that the Air being *Nitrous*, will change the Blood, that has been drawn out of a Vein, whilſt it ſtands expoſed in a Baſon, from a dark, to a bright red Colour, giving it a Tincture perfectly like that which it acquires by the mixture of diſſolv'd *Salt Peter*. We ſhall paſs by all theſe things, by reaſon of the Diſputes and Controverſies of Learned Men, leaving them to be diſcover'd by the following Ages, and confine our ſelves only to an Experimental Enquiry, which of the aforeſaid Benefits and Advantages, or what other are the true ones that may be affirmed, to be communicated by the Air to the Blood.

This is however unqueſtionably true, That the drawing in of the Air is of ſo great a Convenience, that no Body could want it long without Dying; and that our Heart, and the whole Structure of the Veins, are formed after ſuch a manner, by the All-wiſe Creator, that all the Blood of the Body, is made to paſs ſeveral times in an Hour thro' the Lungs, and there ſubjected to the Operation of the Air.

Sect. XIII. *The Diſpoſition of the Air in the time of Peſtilence.*

Now, of how great Importance, beſides the Elaſtical Force and Gravity of the Air, the good Diſpoſition and Conſtitution thereof, is, towards the Preſervation of the Lives of Men, and Beaſts, is very plain at thoſe Seaſons, in which the Air being

being Corrupted, Peſtilential Diſtempers are occaſion'd, and Kings and their Subjects, and Small and Great, are ſnatched away by Thouſands. And theſe kinds of Diſeaſes muſt not be aſcrib'd to any other Cauſe, ſince, being common to all Sorts of Men, they muſt likewiſe proceed from one common Source or Spring; and that can be nothing elſe but the Air, which is common to all Mankind. The famous Profeſſor *Schacht* has given us an Account of a dreadful Example of this Peſtilential Infection of the Air, in the laſt Plague at *Leyden, viz.* by expoſing a Bucket of Water a whole Night to the Air, even within Doors, upon which in the Morning there ſtood a kind of a Cream or Scum of divers Colours, that had been communicated to it by the Air; this being gently skimmed off with a Spoon and given a Dog to drink, the Poiſon was ſo Strong, that he died of it in a few Hours: And how pernicious alſo in general, the Corruption of the Air is, will abundantly appear from the Melancholy Experiments, whereby it has been often ſeen, that People have been miſerably Suffocated, and Periſhed in an Air to which they were accuſtomed all their Lives; as ſoon as that ſame Air becomes Infected, and Poiſon'd with the Smoak of glowing Charcole.

Sect. XIV. *The Air leaves ſomething in the Blood.*

Now the Opinion, that the Air being drawn into the Lungs, leaves ſomething there (whatever it may be) and does not come out again of the ſame Temper, ſeems to be ſomewhat probable from certain Experiments, which I have found among my Notes in the Year 1695, by which it ſhould appear credible, that the Air leaves behind it in the Lungs the ſame Particles which ſerve to maintain Flame. Concerning this, the Reader may have Re-

Recourſe to the *Ninth Section* of the *Twenty firſt Contemplation* upon *Fire*, where the Experiment is ſhewn in all its Circumſtances. Beſides which, there is to be found in the *Memoirs of the French Academy of Sciences*, Anno 1707. p. 213. a Remark of Monſieur *Homberg*, where he ſays, that if any Body has been in a place where there was a ſtrong Scent of Oyl of Turpentine, he will diſcover afterwards that his Urine has the ſame ſmell of Violets, as if he had ſwallowed Turpentine itſelf. Now ſince theſe fine Particles of the Oil of Turpentine do not ſeem to have enter'd his Body, otherwiſe than by Reſpiration, and it being very probable from the ſmell of the Urine, that they muſt have been firſt mingled with Blood, this Gentleman concludes, that the Air leaves ſome Particles behind it in the Blood; but we ſhall not here expatiate upon thoſe things which ſome People hold uncertain.

Sect. XV. *Convictions from the foregoing Obſervations.*

Now can any Body, that has well weighed and underſtood all theſe things, avoid ſeeing that his Precious Life is in the Hands of another, and how greatly we are oblig'd to ſhew our Gratitude for his Goodneſs, in continuing the ſame: *His*, I ſay, who preſerves this great Sea of Air, in which Men live like Fiſhes, in ſuch a Diſpoſition as to make it fit to perform this great Office to the whole Race of Mankind, and ſo many other Creatnres, in preſerving their Lives and enabling them to breath? Or, can the ſame likewiſe be rectified by any Humane Means, after it is corrupted and become fatal both to Rich and Poor? Now if all this be perform'd by Chance, and without the Providence of a Gracious and Powerful Ruler, how comes it to paſs, that in ſo many Thouſand

Years, among ſuch great Revolutions that it undergoes, by Storms, Thunder and Lightning; from ſo many poiſonous Vapours exhaling from Subterraneous Caverns, and from rotten and putrified Bodies, none of 'em all have hitherto been able to deprive it of that Conſtitution by which it preſerves the Lives of all Creatures; ſince if every thing be Accidental, and not under the Direction of a wiſe Being, the one might as eaſily come to paſs as the other? But of theſe and other Properties of the Air, an expreſs mention ſhall be made in its Place.

In the mean time, let every Body, that has the Knowledge of his Maker and Preſerver at Heart, ſeriouſly recollect all that has been ſaid about Reſpiration, and, in a ſilent Retreat, examine himſelf, whether he can maintain with Reaſon, that this Air is not created for this very Purpoſe among others, in order to preſerve the Life of every Creature breathing, ſince this alone, and nothing elſe in the World, has the Qualities that are requiſite thereto? And let him ſay, if he dares, that all that moſt amazing Structure of the Muſcles of the Breaſt is formed by meer Chance only, without any Proſpect of that great End of *Inſpiring* and *Expiring* of the Air, ſince there is here likewiſe ſuch a great number of Muſcles diſpoſed after ſo wonderful an Order, to produce that very Effect only, or hardly any other: Can he imagine, that the Lungs were made without Underſtanding, and placed in the Breaſt after the Manner we have already ſhewn? Whereas, if they had been diſpoſed any otherwiſe, all the Properties of the Air, all the Diſpoſitions of the hundred Muſcles, which now ſerve this Work, would be entirely in vain, and the whole Globe of the Earth would be preſently diſpeopled. Can any one fancy, that ſo many Ribs and Cartilages, of which the Breaſt is compoſed, ſo many Muſcles by which it is moved,

together,

together with the Midriff and Lungs, have met one another in ſuch a little ſpace by meer *Chance*; and that the Air alſo, has encompaſſed them all without any Purpoſe; whereas, if but one of theſe Circumſtances were wanting, the great Buſineſs of Reſpiration, and therewith the Lives of all Creatures, would immediately be ended? Can any one think, that where ſo many and ſo different Things concur to one End, the ſame are not made with this Deſign, that they ſhall be uſeful to each other? He would be aſham'd to maintain, that a curious Lock and Key adapted to a ſtrong Box, and by which alone it could be open'd, was not made by an *Ingenious Workman*, but by meer Chance, by which only they had met together. Unhappy Men! that can continue in ſuch ſenſeleſs Opinions after ſo long and daily Contemplations of thoſe Works of the Creation, in which the Wiſdom of the Creator is ſo viſibly manifeſted.

CONTEMPLATION VIII.

Of the Structure of the Veins.

SECT. I. *The Tranſition to the Veins.*

WHAT has been ſaid ſeems to be more than ſufficient not only to bring a *Sceptick* into the right Way, but even alſo to convince the moſt obſtinate *Infidel*, that our Bodies muſt have been formed by a Wiſe Creator, and that the Origin

thereof can be aſcribed to nothing leſs than an *Accidental* and *Ignorant Cauſe*; yet, if there ſhould ſtill be any Body who either thro' want of conſidering what has been already ſaid, finds himſelf unmoved, and conſequently unconvinced thereby; or, altho' he has underſtood it, yet ſhould with-hold his conſent to the Concluſions that flow from thence; let him go but one ſtep farther with us, and ſee whether, without Contradiction of his own Conſcience, he can contemplate the wonderful Structure of the Tubes thro' which the Blood circulates, and which are contriv'd for ſo many Purpoſes; and then believe, if he can, that He who formed them all, propoſed no End to himſelf when he made them, nor knew what He himſelf was, nor what He had Created.

Sect. II. *The Courſe of the Arteries.*

Now in order to the compleat Conviction of all ſuch *Atheiſts* and *Scepticks*, they are intreated ſeriouſly to conſider with us, whether it can be imagined, that the Veſſel (*Tab.* II. *Fig.* 3.) which is called the *Aorta*, *Arteria Magna*, or *Great Artery*, has, without an over-ruling Underſtanding or Deſign, acquir'd ſuch a Form as is ſhewn from *Verheyen*, in *Tab.* III. *Fig.* 4. in the particular Scituation wherein it appears in Humane Bodies.

Beſides other Wonders which we don't meddle with here, we know, that there is not any one Part of the Body, as yet diſcover'd, in which we find that the Blood is not convey'd thither by the Branches of this great Artery, either for Nouriſhment or Motion, and likewiſe for the Separation of other Humours and farther Uſes. Will any Body therefore believe, that this whole Diſpoſition of the Arteries, has been thus contrived by Accidental or Ignorant Cauſes?

Now

Now in order to impart ſome rough Conception or Idea hereof, which might otherwiſe appear a little obſcure to thoſe that are unexperienced; let us here repreſent to ourſelves the Beginning A O of this Artery, as cut off from the Heart at O, and we ſhall ſee two little Arteries *a a*, called the *Coronary Arteries*, coming out of the ſame, and turning towards the Heart; the ſame are repreſented a little bigger in *Tab.* II. *Fig.* 11. B B.

Then if you aſcend as it were ſtreight forwards, you may ſee in *Tab.* III. *Fig.* 4. the *Carotides b b*, proceeding out of this Veſſel, the Pulſe of which a Man may feel with his Finger on each Side of his Wind-Pipe; theſe having, as they go on, communicated ſome Branches to the Wind-Pipe and Parts adjacent, do each divide themſelves into two Branches, one of which, *e e*, goes into the Head, to the thick Membrane of the Brain, to the Mucilaginous Glands, to the Eyes, to the inmoſt Parts of the Ear, and to the Subſtance of the Brain itſelf; and t'other Branch, *d d*, proceeds to thoſe Parts that compoſe the outſide of the Head, and is the ſame which is felt in the Temples of the Head.

We may obſerve farther, that this great Artery begins to bend itſelf at A, in order to deſcend on the left Side; that on either Side there appear two great Branches D and L, called the *Subclaviæ*; which, as at F, are again divided into two great Branches, one of which ſeems to terminate at the Elbow, and the other, E, carries the Blood to the remaining Part of the Arm, and the whole Hand, quite down to the Fingers: But before this Diviſion at F, the *Subclavia* ſends out ſeveral Branches; ſuch as the Branch *m* downwards thoſe to the Breaſt, and *n*, whoſe lateral Branches become the ſuperior *Intercoſtales*; there go farther upwards the *Cervicales c c*, otherwiſe called the

Vertebrales, whoſe lateral Branches at *i i* diſcharge their Blood into another common Veſſel *h*, which like a Chain runs along the Back-Bone downwards. Finally, theſe *Vertebrales* goes to the Brain. To ſay nothing more at preſent of all the little Branches, as *k*, which go to the Muſcles of the Neck, *o p*, to the Shoulder-Blade within and without, and all thoſe which we may obſerve to proceed from the Arteries of the Arm.

The great Artery turning itſelf now downwards at B and C, produces firſt the *Bronchialis b b*, which ſeems to feed the Lungs; this is followed by the inferior *Intercoſtales c c*, which come out here acroſs, and are cut off; and under theſe there comes forth ſometimes a Branch to the Midriff *d*, under which is the *Cæliaca e*, which divides itſelf into two Branches, the Right of which goes to the Stomach, to the Cawl or *Omentum*, to the *Pancreas*, to the firſt Inteſtine next the Stomach, to the Gall-Bladder, and inveſting Membrane of the Liver; and the left, after having communicated ſome little Branches to the Stomach Cawl and *Pancreas*, terminates chiefly in the Spleen.

Under this *Cæliaca*, the uppermoſt *Meſaraica u*, comes out of the Great Artery, and runs thro' the Midriff to the thin Inteſtines, in the ſame manner as the Artery *u* does to the thick ones.

s s Are thoſe that go to the Kidneys and to the Loins; *v v* are the Spermatic Arteries.

After all theſe Branches, the whole Great Artery divides itſelf at *w* into two great Branches, called the *Rami Iliaci*, which ſending their Branches to the lowermoſt Bowels of the Belly, as the Bladder, the Matrix, and other Parts of Generation, to the *Inteſtinum Rectum*, *&c.* proceed farther on both Sides down to the Legs, and to the extreme Parts of the Toes, after the ſame manner as the *Vena Subclavia* at F does to the Arms.

SECT.

SECT. III. *The Courſe of the Veins.*

NOw as this great Artery tranſmits its Branches to all the Parts of the Body, can any one imagine, that not one of them, how little ſoever, is to be found, to which there is not again a Vein-branch adapted? Which Branch carries that Blood back to the Heart, that was brought from thence by the Artery, to all the other Parts.

Let thoſe who deſire to form any Notion hereof, caſt their Eyes upon *Tab.* III. *Fig.* 5. and obſerve how theſe Veins run along the Body, and after having performed their Office, carry the Blood back to the Heart: So that the ſame Blood which in *Fig.* 4. (to give one or two Inſtances thereof) was brought from the Heart thro' the *Arteria Subclavia* D, to the Extremities of the Fingers 7, 8, 9, is again received by ſmall Branches of the Vein A N, in *Fig.* 5. by which it returns thro' Q O M G, and is brought thro' a great Veſſel E, called the *Vena Subclavia* to the *Vena Cava* C, and ſo on till it diſcharges it ſelf again thro' the Orifice A into the Heart.

Thus we here ſee the Jugular Veins, *Fig.* 5. *d d*, *e e*, and the *Vertebrales f f*, bringing back the ſame Blood, which in *Fig.* 4. was carried into the Head, and other Parts, thro' the Arteries *b b*, *c c*, and as before, *Fig.* 5. leading it to the Heart A, thro' the ſame *Vena Cava* C.

We muſt ſuppoſe after the ſame manner, that the Blood, which was carried down thro' the Artery T, (*Fig.* 4.) and, as in the Arm, driven to the Extremities of the Toes, is there received firſt of all in the ſmall Veins, in order to bring it back; and farther thro' the Vein I G, *Fig.* 5. along E B, (which is called, *Vena Cava Aſcendens*, becauſe the Blood paſſes thro' it upwards) diſcharges itſelf in the Heart at A.

SECT. IV. *Convictions from both the foregoing Sections.*

NOw ſuppoſing the ſame Phenomena in all the Veins and Arteries, can any one imagine, that this great Artery, and the whole Diſproportion of the Veins, are made without Knowledge and Underſtanding; or that each of them are not thus contriv'd for their particular Purpoſes, of carrying the Blood backwards and forwards? He that will venture to maintain this, how can he be convinced? And let him but ask himſelf, if ſeeing the Pipes and *Aqueducts* of a Fountain (in which there is not the thouſandth part of ſo much Skill or Art as in the Ducts of the Blood) he will dare to maintain, that he really believed that they were all diſpoſed after ſuch a manner, without any Wiſdom, or Deſign, or Contrivance of the Maſter; and that if he ſhould ſay ſo, whether he were like to find any Credit with People of good Senſe or Reaſon?

SECT. V. *A rough Repreſentation of the Circulation of the Blood.*

To the end, that an unexperienced Perſon may, in ſome meaſure, comprehend what has been ſaid above, and have ſome Idea of the Circulation of the Blood, let him fancy, that in (*Tab.* II. *Fig.* 3.) the Tubes or Veins E and F, are the ſame that are repreſented in *Tab.* III. *Fig.* 5. by C and B; from which the Blood paſſes upwards and downwards into the Right Ventricle of the Heart, and thence thro' the Veſſel G (*Tab.* II. *Fig.* 3.) into the Lungs, and thence again thro' another Vein H, into the Left Ventricle of the Heart, which two Veſſels H and G, are ſhewn before, in *Tab.* II. *Fig.* 12. by C E and B E, which encompaſs

encompaſs between them both one of the Branches of the Lungs A E: Laſtly, let him ſuppoſe that the Blood is protruded from this Left Ventricle, by the Contraction or *Syſtole* of the Heart, into the great Artery I (*Tab.* II. *Fig.* 3.) which, how it diſtributes itſelf by its Branches, has been lately ſhewn in *Tab.* III. *Fig.* 4.

So that by this means the way of the ſo famous Circulation of the Blood may appear to any one that conſiders the ſame; which Blood paſſing from the Heart, thro' the Arteries to all the Parts of the Body, is tranſmitted back by the Veins into the ſame, and then having paſs'd thro' the Lungs, between both the Ventricles of the Heart, reſumes the ſame Courſe again thro' the Great Artery.

He that has ever ſeen the Circulation of the Blood in the Tail of an Eel, by the help of a Microſcope, will be very well ſatisfied concerning this Motion, without our producing any farther Proofs thereof, tho' they are very numerous; and he will be no leſs convinc'd of the great Velocity, or Swiftneſs, of the Blood's Motion, if ever he ſaw it ſpringing out of a cut or wounded Artery.

Sect. VI. *How often the Blood Circulates in an Hour.*

Now that we may farther enquire how often the Blood Circulates throughout the Body of a Man in the ſpace of one Day, let us agree with the Great *Harvey* in the following Poſitions.

1. That the Left Ventricle of the Heart may contain about two Ounces of Blood; tho' the accurate Dr. *Lower* has often found it larger.

2. That in each Contraction of the Heart, this Cavity is in a manner quite empty; and therefore two Ounces of Blood are at each time protruded into the Great Artery, which ſwelling up thereby cauſes the Pulſe.

3. If

3. If we now ſuppoſe, that each Pulſe is made in a Second of an Hour, or in the *60th* part of a Minute, which every one may obſerve in himſelf, and is at preſent, for Conveniency ſake, allowed by many, this will produce 3600 Pulſes every Hour; and conſequently twice as many, that is 7200 Ounces will paſs through the Heart in the ſpace of an Hour.

4. This together will make the quantity of 600 Pounds of Blood (allowing with the Phyſicians 12 Ounces to the Pound) that will paſs thro' the Heart in an Hour.

5. Now it is the common Opinion of the Anatomiſts, that a Man has ſeldom more Blood in his Body that 24 ſuch Pounds, or leſs than 15; but ſuppoſing here, with *Lower*, that the ſame amounts to 25 ſuch Pounds, it is plain, that the whole Blood paſſes thro' the Heart 24 times in an Hour, that is to ſay, 576 times in a Day and a Night.

Now if we ſhould maintain with Dr. *Liſter*, *p.* 47. that there are 75 Pulſes in a Minute, or 4500 in an Hour; and that the bare Blood only, which Circulates thro' the Heart, without including other Humours, as the Gall, Spittle, *&c.* which are ſeparated from it, and do not circulate with it, conſiſts of no more than 7 Pounds, as is pretended by ſome, the ſame will paſs thro' the Heart at leaſt 80 Times every Hour, if he allows 16 Ounces to the Pound; and above 100, if but 12 Ounces; but let the Difference be what it will, it is certain it goes thro' it a great many times.

Sect. VII. *Convictions from the foregoing Obſervation.*

Let now an unhappy *Atheiſt* ſit down by himſelf, and fix his Thoughts upon the ſurpriſing Swiftneſs of the Blood's Motion; let him conſider, how great the Strength of the Heart and Arteries

muſt

muſt be, which, during the whole ſpace of his Life, produces ſuch a ſwift Stream of Blood; let him repreſent to himſelf the various Poſition of ſuch numberleſs ſmall Branches of the Veins and Arteries thro' which it flows, and having reflected upon the Misfortunes that happen to a Man, in caſe this Circulation is ſtopp'd even in the very ſmalleſt Branches, and particularly, that all this is brought about in his Body, without any Power of his own Will, and even without knowing or being ſenſible of what paſſes: Let him ask himſelf, whether he can, with a conſenting Conſcience, maintain, that this whole Structure of the Heart, Lungs, Veins and Arteries, was not produced by a Wiſe Maſter; and whether this Blood can be carried about ſo many thouſand Times, for the ſpace of 40, 50, 60, or more Years, through ſuch narrow Veſſels, and never ceaſe moving, unleſs it be by the Direction of a Powerful and Gracious Ruler, who preſerves and ſupports his Life, without the Aſſiſtance of any concurring Creature.

Sect. VIII. *Several Particulars.* 1. *Orifices of the Lateral Branches.*

That we may not be too tedious here, we ſhall paſs by innumerable Particulars, which might prove a Powerful, Wiſe, and Gracious God, even to the blindeſt of Men; and only hint at a few, for for the further Conviction of thoſe deplorable Philoſophers.

Diſſect a Vein or an Artery, length-wiſe, and obſerve how regularly the Orifices in both of 'em lye; thro' which, from the latter, the Blood paſſes into the Branches that Spring out of it, and from the former is received into the Vein out of the Branches thereof.

Sect.

Sect. IX. 2. *The Arteries grow Narrower.*

Can it be imagined eſpecially, that it comes to paſs by Accident, that the Arteries are larger next the Heart, and gradually narrower, and divided into numerous little Branches, as they go farther from it? The reaſon of which is, to prevent the Blood, which iſſues with ſo much Violence out of the Heart, from paſſing by the Lateral Branches and following its way only in the large Veſſels; for if that ſhould happen, the Parts which lye on the Sides, would not be ſufficiently provided with their Share of the Nouriſhing Blood, and ſo would wither or periſh: For it only comes to paſs, by this narrowing of the Arteries, that the Blood flowing from the Heart, puſhes forwards all that it finds in the Artery, to make place for it ſelf; but that not being able to paſs ſo nimbly becauſe of the Straitneſs of the extreme Branches, preſſes every way upon the Sides of the Artery, and expanding the ſame (which is the Cauſe of the Pulſe) ruſhes into the Lateral or Side-Branches with more force than if the Artery had been every where of equal Bigneſs, or of greater than it had at its Beginning.

And muſt not every Body confeſs, that he can, as it were, feel with his Hands our Great Creator's End and Deſign in theſe Orifices that are found in the Arteries, and out of which the Side-Branches ſpring, if he has ever ſeen the Obſervations of that exact Anatomiſt *Lower*, in *Tab.* III. *Fig.* 6. where at *o b c d*, the Great Artery coming out of the Heart at *o*, and the Branches ſpringing out thereof, *a a a*, making the *Cervicales* and the *Arteria Subclavia*, are repreſented. Now if the Blood were protruded from *o*, through *b* and *c*, to *d*, it would paſs by theſe Branches, by reaſon of the wideneſs

wideneſs of the Artery, at leaſt, there would be leſs Blood communicated to them than was requiſite; for which reaſon the Great Creator has placed ſuch Protuberances at *c*, on the ſide of the Orifice, as may in ſome meaſure ſtop the Paſſage of the Blood in its way from *o*, thro' *c*, to *d*, and cauſe it to turn its Courſe into theſe Branches. Can any one here likewiſe deny a *Deſign*, and think that all this comes to paſs by *Chance*? Why then does not the ſame Phænomenon occur in all other Branches, tho' wanted there?

SECT. X. 3. *The Arteries contract themſelves.*

BUT altho' the Blood that comes out of the Heart, does require a ſufficient Swiftneſs by the Contraction thereof, yet there ſeemed to be danger that the Heart expanding itſelf, in order to receive New Blood, two pernicious things might happen, *viz. Firſt*, That the Blood might by its weight fall back into the Heart; and *Secondly*, that the Contractive Faculty of the Heart ceaſing, the Circulation of the Blood might likewiſe be ſtopped.

How the former is prevented by Valves, has been already ſhewn, when we treated of that Matter; and as to the latter, can any one imagine that it happens by Chance and without Deſign, that in the Arteries themſelves, where they have any Largeneſs, the Membranes of which they are made up (much like what has been ſaid about the Throat) have, beſides the Tunic A, (*Tab.* III. *Fig.* 7.) thro' which the Blood-Veſſels for the Nouriſhment of the Artery, and the Nerves particularly run, and B, where there are many little Glands, ſtill another Tunic C, which conſiſts of ſeveral Annular Fibres lying upon one another; and under theſe the Fourth, D, which is Membranous, and provided with long Fibres running ſtreight forwards, which are thicker, and more fleſhy near the Heart.

Now

Now when the Artery is filled by the Blood that comes out of the Heart, to the end, that the Circulation ſhould not be obſtructed, theſe Annular Fleſhly Fibres contract themſelves, and ſo make the Artery narrower on all ſides; by which means the Blood being prevented from going back to the Heart, is forced to proceed forwards and ſide-ways, and thus the Circulation of the Blood is inceſſantly continued, even while the Heart is open, and cannot protrude it.

Does not all this *Apparatus* of Inſtruments, which compoſe the Arteries, diſcover that they muſt have been formed by an Underſtanding Artificer, who has adapted them all to wiſe Ends and Purpoſes?

Sect. XI. 4. *The Pulſe is not felt.*

Besides all this, foraſmuch as theſe Arteries ſpread themſelves thro' our whole Body, and at every time upon each Contraction of the Heart are expanded with ſo great a Force, and do Day and Night occaſion ſo ſtrong a Beating as we find by the Pulſes, who can conceive the Reaſon why we are not ſenſible of it as long as we are in Health, notwithſtanding that we may find them beat ſo ſtrongly in many Places, if we do but lay our Finger upon them?

'Tis true, that ſome lay it down for a Maxim, *De Conſuetis non judicat Anima*; that is, *Our Mind does not judge of that which we are uſed to do.* But if this were true, we ſhould judge as little of our *Reſpiration* as of our *Pulſe*, being accuſtomed as much to the one as to the other; and yet we find, tho' we often breath without thinking of it, that with never ſo little Attention we can perceive the Motion of the Air in our Mouth, Noſtrils, Wind-pipe, and Lungs, and diſcover from the Action it ſelf that we breath; whereas, on the contrary, let a Man

a Man that is in good Health attend with as much Care as he can to the Beating of his Heart and Pulſes of his Arteries, he ſhall not perceive them in the leaſt.

Does there not then appear, in a very particular manner, the Wiſdom and Goodneſs of our Great Creator in this matter likewiſe, who, that the Attention which we ought to give to other things, might not be diſturbed by this continual Pulſation, has been pleaſed to render us inſenſible of it? And tho' an Atheiſt cannot, or will not, ſee this, yet whoever acknowledges a GOD, may learn from thence, that it is his Duty to fix his Thoughts upon his Maker and his Works, who has ſo graciouſly wrought this Wonder in him, to the end that his Attention ſhould not be drawn away by this continual Beating of the Arteries.

Nor can any aſcribe this to any material Property of the Arteries themſelves, foraſmuch as every body is but too ſenſible, to his own Damage, of all theſe Beatings, when in a Fever, or other Diſtempers, the Fibres are extended by the Blood more ſtrongly than uſual. The ſame may be obſerved particularly, when in great Diſorders and Frights the Annular Fibres are contracted more narrowly, and after a cramping manner, than they ought to be, by the irregular Motions of the Humours of the Nerves which move the Arteries; ſo that theſe Veſſels being become ſtreighter, the Violence which they ſuffer from the Blood iſſuing out of the Heart, is more ſenſible than uſual. This is known to them that have heard the Complaints of ſome Women, who (as it is ſaid) being ſubject to ſudden Diſorders upon the leaſt Accident, do many times feel their Arteries beat throughout their whole Body.

I don't know whether it may be uſeful to add here, that the Contraction of the Arteries, and other Parts of our Body, upon the account of Frights,

Frights, ſeems in ſome meaſure to be confirmed, becauſe in ſuch great and Heart-affecting Motions, the whole Body is often put into a cold Sweat, which is known to proceed from the Contraction of the Glands in the Skin, that are thereby forced to protrude their Moiſture; and if there be any ſmall Hairs planted in theſe little Glands, they will riſe up on end by the Contraction of the ſame; which Phœnomenon People may have often obſerved upon a Fright, not only in themſelves, but in Beaſts too.

Sect. XII. 5. *The Concurrence or Conjunction of the Veins.*

If it be not owing to the Wiſdom of the Creator, that there is no Part in the whole Body to which the Blood does not extend itſelf, and from whence it likewiſe returns; how comes it to paſs, that Arteries meet Arteries, and Veins meet Veins ſo frequently, and diſcharge their Blood into each other, to the end, that in caſe any of 'em all ſhould be diſabled by Amputation, Obſtructions, or otherwiſe, the Blood might paſs another Way to or from the ſame Place?

Sect. XIII. 6. *The Diviſion of the Arteries into Capillary Tubes.*

Two Things more may be obſerved, touching the Circulation of the Blood thro' its Veſſels; in which, no leſs than in the foregoing, the Wiſdom of our Adorable Creator ſhines out as clear as the Sun at Noon-Day.

The firſt is, that from the ſtrong and ſwift Motion of the Blood in ſuch Arteries as are large, there ſeems to be a Danger, that by reaſon thereof the Blood cannot contribute any thing towards the

the Nouriſhment of the Veſſels themſelves thro' which it runs ſo faſt. Can one conſider then without Amazement, that, to obviate this Inconvenience, the Arteries are divided in thoſe Places where this Function is required, into an unſpeakable Number of fine and narrow Tubes, which the Anatomiſts, by reaſon of their Smallneſs, are wont to call *Vaſa Capillaria*, or *Vaſa Minima*; that is to ſay, Veſſels that are as ſmall as a Hair, and ſo little, that they cannot therefore be deſcribed among the Arteries in *Tab.* III. *Fig.* 4. and all this to the end, that by paſſing thro' theſe *Defilés* or By-ways, and ſticking to the Sides of ſuch narrow Veſſels, the Blood might proceed more ſlowly where it is neceſſary that it ſhould do ſo, whilſt that which paſſes thro' Veſſels ſomething wider, may purſue its Courſe to the Veins with greater Swiftneſs.

Sect. XIV. *6. The Narrowneſs of the Tubes leſſens the Swiftneſs of the Blood.*

Now that a fluid Body protruded with the ſame Strength, runs more ſlowly through narrow than wide Pipes, for the above-mention'd Reaſons, is well known to all Fountain-Makers, who can make the Pipes, through which the Water is to paſs, ſo narrow, that by the ſticking of the Parts of the Water to the Sides thereof, the Stream ſhall not riſe near ſo high as it would do thro' larger Pipes: And if any Body doubts this, he may have an ocular Demonſtration of it, by the following very eaſie Experiment.

Let him take the Glaſs Tubes E F G, of different Bores (*Tab.* IV. *Fig.* 1.) of thoſe we made Uſe of (as I find it upon my Notes;) one of 'em E, was a narrow Neck of a broken Thermometer; the Second F, was ſomething larger, and about

the ſize of the Tube of a Barometer, or the Quill of a Pen; the Third G, was ſo large that one might thruſt ones Finger into it. Then let him tye a little Thread about each of 'em at H, K, M, ſo that their Parts H I, K L, M N, may as near as poſſible be of equal length; and putting them into a long Glaſs, A B C D, which is filled with Water up to A B, let their lower Ends, I L N, reach almoſt, but not quite to the Bottom D C, in ſuch manner, that the Threads H K M, may be even with the upper Surface of the Water: Then if he ſtops theſe Tubes with his Finger, at E F G, and thruſt them (being empty, or rather full of Air) one by one, perpendicularly down into the Water, and ſuddenly remove his Finger from the Orifice, he will ſee the Water in the narroweſt Tube E, riſe up even with, yea, viſibly above, the Superficies of the External Water H: Whereas in the Tube F, the Water will riſe up as high as O, and in the Tube G, yet higher to P. Now thoſe that are skilled in *Hydroſtaticks* know, that equal Parts of Water lying in the Horizontal Superficies Q R, which paſſes under the Orifices of the three Tubes I, L, N, are preſſed upwards with equal Force; and therefore, that the leſſer Force, which appears in the aſcent of the Water in the narroweſt Tubes, muſt only be aſcrib'd to the greater Narrowneſs thereof.

Now whether the Curvity of Angles, made by theſe little Branches of the Arteries; as alſo, whether their Multiplicity (ſo that being taken together, they may by reaſon of their Numbers, have more Wideneſs than the great Artery alone) do contribute any thing towards the ſlower Motion of the Blood, we ſhall not enquire farther here.

Sect. XV. 7. *The Veins grow Wider.*

The *Second* thing is, That in caſe the Blood, which thro' larger Veſſels runs ſwiftly along the Arteries, ſhould retain the ſame Swiftneſs in the Veins, by which it is carried back again into the Heart, there would be danger, that the Heart ſhould be overflowed with too much Blood, and the Right Ventricle of it filled ſo full, that it could not be able ſufficiently to exert its contractive Faculty.

Now to prevent ſuch pernicious Swiftneſs, could any Body have thought of a wiſer Expedient, than to have made theſe Veins larger and larger, as the Blood came nearer from the Extreme Parts to the Heart, as may be ſeen in *Tab.* III. *Fig.* 5. quite contrary to the Arteries, which in *Tab.* III. *Fig.* 4. grow continually ſmaller from the Heart to the Extreme Parts.

Now that a Liquor paſſing thro' a narrow Veſſel into a wider, runs ſlower in the ſame ſpace of Time, is obvious enough to every one, without proving it experimentally; but if he has a mind to ſee it that way likewiſe, let him fill a Pipe with Water, and thruſt it with its Orifice downwards, into a Bucket, which has likewiſe Water in it to a certain Heighth, and forcing the Water as faſt as he can out of the ſaid Pipe, he will find, that the Water in the Bucket will aſcend but to a very ſmall Heighth, tho' all that was in the Pipe came out of its full Length at the ſame time; from whence it appears, that the Water in the narrow Pipe moved more ſwiftly than that which was in the wider Veſſel: But this is ſo plain, that we need ſay no more of it.

Sect. XVI. 8. *The little Valves in the Veins.*

But ſince the Blood moving more ſlowly in theſe Veins (*Tab.* III. *Fig.* 5.) might, by reaſon of its weight, (eſpecially in thoſe that carry it directly upwards) endeavours to ſink down or go back, and ſo in long Tubes forcibly reſiſt this ſlower Motion; may we not again diſcover here the Providence of the Creator, exerting it ſelf in ſo peculiar a manner, who has thought fit to place little Valves in theſe Veins; ſometimes but one, as in *Tab.* IV. *Fig.* 2. at A; ſometimes two together, as at B B, whoſe Buſineſs is to ſtop the Blood when it attempts to go back, and that it may not, by its Weight, preſs too much upon that which follows, and thereby retard its Motion?

Now, is all this done by Chance, and without Deſign? Why then are theſe Valves fixed in the Veins, where they are ſo ſerviceable, and not in the Arteries, where they are ſo far from being neceſſary, that they would be prejudicial?

Sect. XVII. 9. *Of the Fibres in the Veins and Arteries.*

We muſt add one thing more, and ſo conclude theſe Remarks, which would otherwiſe, as is well known to thoſe that underſtand it, ſwell to a much greater bulk: Can any Rational Man then perſwade himſelf, that the Great Creator had no End at all, or that it came to paſs merely by Chance, that in the Arteries, where the Blood ſtood in need of more ſtrength, in order to inſinuate itſelf into the narrow Paſſes of their extreme Branches, the Muſcular Fibres, by which they are contracted, are very ſtrong in thoſe Parts; and on the contrary, in the Veins, which continually grow larger, and

in

in which too great a Swiftneſs and Contraction would be hurtful, the Fibres are far from being ſo ſtrong or ſo numerous? But that which the Wiſe Creator cauſes us to feel as it were, with the Hand, is that in the *Vena Portæ*, the like Fibres are again Stronger than in other Veins, tho' fewer than in the Arteries; thoſe being the only Veins of all thoſe of the Body, whoſe Branches, entering into the Liver, grow narrower and narrower; for which reaſon they require more Strength than other Veins, to the end, that like the Arteries, they may oblige the Blood to paſs on to the narrow Ramifications, and to the Glands of the Liver.

Sect. XVIII. *The Uſes of the Blood in General.*

Now to paſs by other Particulars concerning the Blood and Veins, of which we have already treated very fully, the Thread of our Diſcourſe ſeems to lead us to the Uſes and Motions of this Blood.

There are Three particularly, that, among others, are known to depend either wholly, or in part, upon the Blood: The *Firſt*, is the Separation of ſo many different Humours, which are either neceſſary to the Body, or muſt otherwiſe be diſcharged. *Secondly*, the Nouriſhment of the Body. *Thirdly*, The Motion of the Muſcles.

Now whilſt we are going to treat of the firſt of theſe in its order, let no Body think that we deſign to enumerate the various Opinions of many learned Men thereupon; being contented to ſhew the External Diſpoſition of ſome, ſo far as it is known, ſince Men have not yet been able to penetrate all that belongs to it, beſides, it was both out of our Power and Deſign too, to handle his Matter alone in this Place. A rough and ge-

neral Account of the Uſes of theſe ſeparated Humours will be more than ſufficient for our Purpoſe, which was to convince a Sceptical Mind, that we are formed by a God abounding with Wiſdom and Goodneſs.

Sect. XIX. *The Enumeration of ſeveral Humours.*

Now to paſs over the *Lympha*, which is ſeparated in ſo many Places, the Gall in the Liver, the Juices in the Pancreas, and in numberleſs other Glands, the Humours in the Stomach and Inteſtines, in the Eyes, Noſe, Ears, Mouth and other Parts; foraſmuch as there are ſtill different Opinions about them and their chiefeſt Uſes: Can one ſee that there is diſcharged from the Brain ſo Powerful and Spirituous a Humour, which is derived by the Nerves to all the Parts of the Body, rendering ſo many and ſuch important Services, and being particularly the chiefeſt Cauſe of all our Motions; that there exhales from the Pores of the Skin, and by Reſpiration, an inviſible and continual Vapour (ſuppoſing a Man to be in good Health) in ſo vaſt a Quantity, that the accurate *Sanctorius* has diſcovered, that this alone does exceed every day all the other groſſer and viſible Evacuations?

Can any Body believe, that it happens without a fix'd Purpoſe of our Great Preſerver, in order to continue upon the Earth the Race of Mankind in their Children, that the *Materia Seminalis*, for the Procreation of them, is ſeparated from the Blood; and that the Milk flows from the Breaſts of the Females for the Nouriſhment of their tender Sucklings? Can any Body contemplate the Diſpoſitions of the Water-Courſes, when the Blood is ſeparated from its Salts in the Kidneys, without diſcovering the Finger of his adorable Creator in all theſe Things?

Sect.



fronting page 114

TAB. II

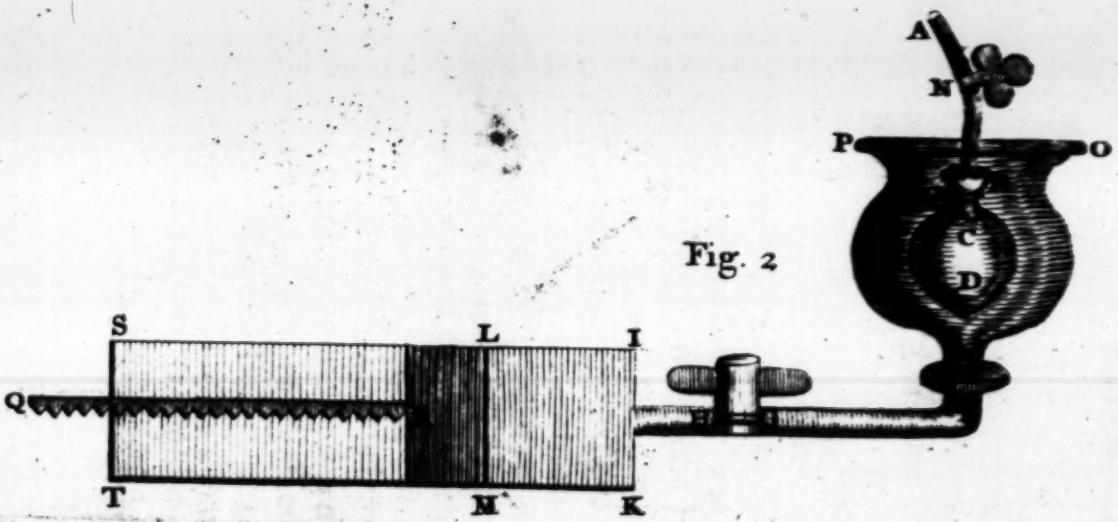


Fig. 2



Fig. 1



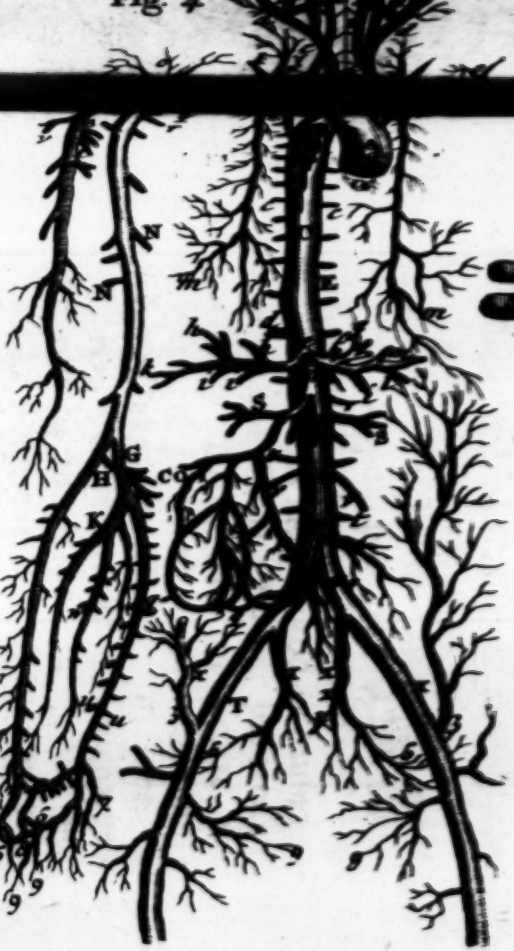
Fig. 5.



Fig. 4







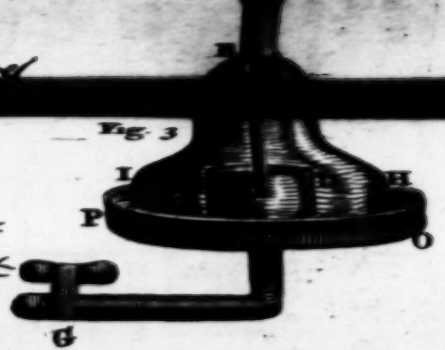


Fig. 3



Fig. 6



Fig. 7

Sect. XX. *The Paſſage of the Urine.*

And to the end that all that has been here ſaid may not paſs for Declamation, or Rhetorical Figures, let us examine a little more cloſely the Diſpoſitions that are made in the ſolid Parts of the Body, for theſe three laſt mention'd Humours; without enquiring into that great and wonderful Myſtery, how each of them has acquired its peculiar Faculty or Property, which hitherto remains among the Secrets of the Great Creator.

Now to give ſome Notion thereof to an unexperienced Perſon, let him ſuppoſe, in *Tab.* IV. *Fig.* 3. that the Blood deſcends from D to *u*, thro' the Great Artery D *u*, of the Heart; and becauſe the ſaid Artery at *u*, and in the farther proceeding Branches, grows continually narrower, that the ſaid Blood is forced to paſs into the Side Branches; by which means it takes its Courſe thro' one of them, F, to the Kidney B, where having diſcharged its Salts, it returns by the Kidney Vein W, and ſo proceeds by C, along the *Vena Cava* upwards, again to the Heart.

In this Kidney (the internal Structure of which is repreſented (*Tab.* IV. *Fig.* 4.) the Humour of which the Urine is compoſed, ſeems to be ſeparated in the outmoſt Glandulous Subſtance, A A: Do we not here, without going any farther, perceive the wonderful Operation of the Deſigns of the adorable Creator, who makes this Humour deſcend thro' ſuch narrow Veſſels B B, which being collected into a kind of little Nipples, called by the Anatomiſts *Carunculæ Papillares*, do filtrate this watry Matter with its Salts into larger Membranous Veſſels, *c c c*; which do again diſcharge what they had received, for the moſt part, into two great Spaces, out of which there is made one

great one, C, called the *Pelvis*; thro' the Orifice thereof this Liquor deſcends farther into the Tube D, or the *Ureter*, which being joyned to the *Pelvis*, do repreſent a compleat Funnel with its Pipe, which being inſerted at Y Y, (*Tab.* IV. *Fig.* 3.) in the Bladder H, makes on each ſide a Veſſel G Y, in order to diſcharge that which is brought into it?

Two things ſeem to be requiſite here; *firſt*, that the Urine coming into the Bladder, may be driven out of it again; and, *ſecondly*, that in order to prevent Inconveniencies, it ſhould not happen continually, nor without our Will. Now can it be imagined, that it is without Knowledge and Deſign, that there ſhould be Muſcles likewiſe placed in the Bladder, in order to contract it, and force out the Water, beſides the Muſcles of the Belly which could have preſſed it; and particularly, that tho' the Bladder were contracted and drawn together, that which is contained might have burſt out at every Orifice, if it had not been ſo contrived that that Humour ſhould not be able to return thro' the Orifice Y Y, by which it deſcended from the *Ureters* G, but only thro' that Paſſage which Nature has preſcribed it?

Thus we ſee that it is eaſie to blow up the Bladder H, by one of its *Ureters* G Y, but if it ſhould be blown by that Tube, thro' which the Urine comes out, the very Children know, that the Wind cannot paſs that way thro' the Orifices of the *Ureters*.

And as for what relates to the ſecond thing, we may obſerve, that the Bladder is fortified with a ſtrong Muſcular Valve at the lower end of it, to prevent the Leaking of its Humour, and is ſhut up by the ſame till a greater Force obliges it to give way, and ſuffer the Water to paſs thro' it.

Add thereto, that becauſe this Humour is almoſt always Salt, and often ſharp, the moſt gra-

cious

cious Care of our Creator (to the end, that it ſhould not corrode the innermoſt Membrane of the Bladder, which is exceeding ſenſible, and ſo occaſion Pain) has fortified the ſame with a kind of a tough and ſlimy Moiſture againſt it in the inſide.

Sect. XXI. *The Breaſts of Women.*

The ſame Wiſdom appears in the adapting other things to their Ends, ſuch as the Tubes of the *Ductus Salivales*, and eſpecially in the Structure of thoſe Ducts, by which the Gall paſſes from its Bladder, and from the Liver to the Inteſtines; and the Veſſels of other Parts, where the Humours are ſeparated from the Blood.

But can he, who ſees no more than the little Glands A A, in the Breaſt of a Woman (*Tab.* IV. *Fig.* 5.) (the external Tegument being taken off) in which the Milk is ſeparated from the Blood; and the little Tubes *b b*, into which it flows, and where it is preſerved, to the end, that it may in proper time be ſuck'd out thro' the Nipple C, where they are open, and in which they terminate: I ſay, can he that ſees theſe things imagine, that this only part, to deduce no Arguments from all the reſt, had not a Maker, who deſtined it to perform a Service ſo very important to all Creatures in their moſt tender Age?

Sect. XXII. *The Structure of the Seminal Veſſels.*

Now that every one may be yet farther convinced, that all the Parts of our Body are with great Wiſdom adapted to particular and certain Uſes; let us go on, and conſider the other Parts repreſented in *Tab.* IV. *Fig.* 3.

1. How the Spermatic Arteries P P, coming on each ſide out of the Great Artery *D u*, do deſcend to

to the Teſticles, therein to diſcharge the Seminal Matter which they bring thither with the Blood, the Remainder of which is carried back again from the Teſticles to the Heart by two Veins O and *n*, and with how many Windings and Turnings the ſame aſcend, may be ſeen on the left Side *o o*, where they are repreſented as ſtretcht out; whilſt the Artery P, deſcends ſtreight forwards in a Man, as *Verheyen* has obſerv'd.

And, that we may all ſee that the Wiſdom of our Creator extends itſelf to the meaneſt Things, it need only be remark'd, that the Arteries P P, do, for the moſt part, proceed immediately from the Great Artery D *u*; but that the Veins O and *n*, thereto belonging, do not both, but only one of 'em, *viz.* O, and on the Right, diſcharge itſelf into the *Vena Cava* C *u*, whilſt the Left *n*, is inſerted into the Kidney Vein W, becauſe it was to be feared, that as it took its way into the *Vena Cava* C *u*, the courſe of its Blood might be obſtructed at every ſwelling of the Artery, by reaſon of the continual Pulſe of the Great Artery, over which this Vein muſt have neceſſarily paſs'd, as appears by the Figure; ſo that by this Conveyance of the Blood, from *n* to W, and from W to C, (which otherwiſe, if it ran as at O would be ſhorter) this Inconvenience is prevented by a careful Providence, and it is fully prov'd, that it intervenes in ſo ſmall a Matter as the Courſe of this Vein.

2. That in order to bring the Seminal Matter, ſeparated from the Blood in the Teſticles, to its deſtin'd Place, two Tubes, R R, or *Vaſa Deferentia*, aſcend from the ſaid Teſticles, and carry the Seed into the *Veſiculæ Seminales*, which appear on one Side behind the Bladder X X, and there it is preſerv'd till the time of its Uſe.

3. That the End of theſe Seed-Veſſels is ſtop'd by little Glands, which prevent the Matter from diſtilling

diſtilling out of its own accord, and yet do not obſtruct the ſame when Ejection is neceſſary.

4. That in each of the Groins there is a peculiar Tube made for that purpoſe, of the Membrane that lines the Belly, call'd the *Peritonæum*, thro' which the Seminal Veſſels or *Vaſa præparantia* O P deſcend, and the Seminal Ducts or *Vaſa deferentia* R R, aſcend; as may be ſeen *Tab.* II. *Fig.* 1. W W.

And particularly, to prevent the Inteſtines from preſſing into the *Scrotum* or Cod, and cauſing what we commonly call a Burſten or Broken Belly, theſe Tubes are cover'd with a Membrane in *Men*; but in Dogs, and other Creatures, whoſe Poſture is not erect, and conſequently which are in no danger of ſuch Accidents, the ſame Tubes have no Coverings, but are quite Open.

Sect. XXIII. *Convictions from the foregoing Obſervations.*

There are whole Volumes written to ſhew all the Particulars of theſe Parts only; we ſhall therefore go no further, but leave it to every one that Reads and Underſtands what has been already ſaid, to examine himſelf, whether he can believe, that in all theſe Matters about the Seed, Bladder, Breaſts, *&c.* the Wiſdom of a Creator has had no Room; and whether he can admit, that among thouſands of Differences, any one of which, in caſe all things had been produced by Chance, and without Underſtanding, might have here equally come to paſs, theſe only ſhould have taken effect; all of which are ſo well adapted to ſuch Great and Neceſſary Purpoſes? I can't forbear ſaying one word here likewiſe to ſome other Philoſophers, and obſerve, that ſince, as we have juſt now ſhewn in *Tab.* IV. *Fig.* 3. the Spermatic Vein *n*, on the Left Side, does not take the ſhorteſt and moſt

ſimple

ſimple way to the *Vena Cava* C *u*, as that on the Right Side does in O; but making a Tour, does firſt inſert and diſcharge itſelf in the Kidney-Vein W; that it is in vain to affirm, that thoſe Hypotheſes carry the greateſt Truth with them, which appear to us to be the moſt ſimple, and to produce every thing after the ſhorteſt Manner; foraſmuch, as there may be unknown Reaſons, as here in the Caſe of the Great Artery D *u*, why the Supreme Architect, in order to bring about his other Purpoſes, may think fit to depart from that Method, which would otherwiſe be more ſhort and ſimple in the Production of that End only.

Sect. XXIV. *The Nouriſhment and Motion of the Blood, not yet fully known.*

Now it would be time to paſs on to the other Uſes of the Blood, namely, the *Nouriſhment* and *Motion*: But foraſmuch as the Ways of the Great Creator, are in theſe Matters, even to this time, inſcrutable to us, and that the Structure itſelf of the ſolid Parts are not yet fully known, but do abound with Diſputes; we judge it more ſafe to be ſilent therein, than purpoſely to offer only Gueſſes and Uncertainties, or Poſitions, which are not yet ſufficiently received by Learned Men, how probable ſoever they may ſeem; the Adorable God has not however left himſelf without a Witneſs, to every one that ſeeks him, in numberleſs other Matters, the Certainty of which, can by no means be called in Queſtion.

CON-

CONTEMPLATION IX.

Of the Nerves, and briefly of the Lymphatick Veſſels, Glands and Membranes.

SECTION I. *The Tranſition to the Nerves.*

WHEN we were treating about the aforeſaid Separation of the Humours of the Blood, it would have been proper enough to have mention'd thoſe of the Brains and Nerves, as a kind of Humours; but wirh reſpect to our Deſign, the ſo important Uſe thereof, the ſo wonderful Texture of the whole Series of the Nerves, which, like the Arteries for the Blood, ſerve for Veſſels to convey theſe Humours; they are by much too conſiderable to be handled curſorily, without ſaying ſomething particular of them too.

Now then, in order to convince an unhappy Philoſopher, of the Perfections and Wiſe Deſigns of his Maker, nothing more ſeems to be required, than to move him to look into the Enquiries and Obſervations of the Anatomiſts, and eſpecially of *Willis* and *Vieuſſens*, and endeavour to acquire a juſt Idea of the Concatenation of this wonderful Structure, of the innumerable Multitude of the little Branches of the Nerves, of which there is not one that is made, but what is of great and peculiar Service to the Body.

To repreſent ſomething of this Matter here, let him caſt his Eyes upon *Tab.* IV. *Fig.* 6. and conſider, if

if each of theſe fine Branches performs its Function, (and ſome of 'em are ſo very neceſſary, that if they ceaſe, they put an end to our Lives;) whether theſe Nerves that appear to the Eye of an unexperienc'd Perſon, ſo irregular and confuſed, and yet in themſelves are ſo well diſpoſed, that there is not one of 'em, yea, not the ſmalleſt Branch or Sprig of 'em but has its Uſe; let him conſider, I ſay, whether all this can be performed by Chance? He that deſires to be more fully convinced hereof, let him conſult the Large Figures of Mr. *Vieuſſens*.

Sect. II. *Different Opinions about the Matter that paſſes thro' the Nerves.*

It was well enough known to the Ancients, that all the Nerves are a kind of Veſſels, thro' which a certain Matter, that deſcended from the Brain into the Muſcles, was either an entire, or at leaſt a concurrent Cauſe of their Motion: Becauſe, if a Nerve was cut off, obſtructed, or otherwiſe diſabled, the Muſcle to which it belonged, notwithſtanding all endeavours to the contrary, would remain without Motion.

This Matter is conceived by all to be indeed fluid; but by ſome 'tis ſuppoſed to be a Wind or Spirit, and is therefore called the Animal Spirits, and is believ'd to paſs thro' the Nerves with a Swiftneſs like that of Lightning; it being otherwiſe impoſſible to reconcile the unconceivable Quickneſs of the Motion, which we ſee performed by Creatures in ſo ſhort a ſpace of Time, with the ſlow Courſe of a Liquor: Upon this Foundation, there are ſuppoſed to be Valves, and many other things in the Muſcles, in which Suppoſitions there is Ingenuity enough, if there were but enough of Truth too.

But

But theſe Opinions are called in Queſtion; *Firſt*, becauſe it has been ſufficiently proved by Chymical Experiments, that ſo very volatile a Matter is not always required towards the producing a ſwift and violent Motion; accordingly, it has been ſeen, that by the Mixture of Oyl of *Vitriol*, and Salt of *Tartar*, the firſt of which has little, and the other hardly any Volatility it it, a ſtrong and ſudden Fermentation has been produced. We are taught by a like Experience too, that Salt Petre, Brimſtone, and Charcoal, which are not counted among volatile things, being mingled together into Gun-Powder, have occaſion'd ſuch Motions, as for Swiftneſs and Force, have not yet been equal'd. The ſame appears from the Glaſs of Antimony, which being a fixed Body, (or at leaſt ſo volatile, that it is able to reſiſt a very ſtrong Fire for a long time, as is well known to the Chymiſts) has yet the Faculty of producing ſuch great Commotions and Contractions in Humane Bodies, even ſo ſmall a quantity of it, that thoſe who have tried it own it to be wonderful: Others deduce the Motions of the Muſcles from Hydroſtatical Laws, which therefore need not ſuppoſe ſo great a Swiftneſs of the Nervous Juices.

Secondly, the Courſe of the Nerves being now better known to the Anatomiſts, it has been diſcover'd by the Complaints of their Patients, that it was probable, that a ſlowly moving Matter paſſed thro' the ſame; which ſeemed to be in ſome manner more credible when it was conſider'd, how improper the moiſt Subſtance of which the Brain and Nerves are compoſed, appear to be for affording a free Paſſage to any thing that was to move thro' them with ſo unconceivable a Swiftneſs as the matter of Wind and Spirits.

Sect III. *An Experiment to prove a Nervous Juice.*

But particularly the Experiments taken afterwards by Meſſieurs *Bellini* and *Malpighi*, ſeem to have put the Matter beyond Conjecture, and to prove, that there is a tough Humour (which they called *Succus Nervoſus*, or the Nervous Juice, in oppoſition to the *Animal Spirits*) which run thro' the Nerves.

For if you diſſect the Breaſt of a Creature, in which there is ſtill a little Life, or that is but juſt Dead, and with the Fingers of one Hand, preſs the Nerve of the Midriff in ſuch a manner, that nothing can deſcend from the Brain into it by this Veſſel; and after that, go on to preſs with the other Hand, that Part of the ſaid Nerve, which is between the firſt Preſſure and the Midriff, ſo as to drive whatever it contains forward into the Midriff; it will be found, that the Midriff will reſume the Motion which it haſt loſt, and continue it till the Humour that was in the Nerve be quite protruded: But if you looſen the Fingers of the Firſt Hand, and admit a New Paſſage to that which comes from the Brain, you will ſee, after ſome time, that, as ſoon as this New Humour reaches the Midriff, the Motion of it will be renewed. Conſult *Bergerus* upon the ſame, *Page* 260. and, that one may have ſome ſolid Foundation, that the Matter of the Nerves is of the Nature of a Liquor, and not of a Spirit or Wind, the great Enquirer, *Malpighi*, has ſhewn, that by preſſing the End of the Great Nerve, in the Tail of an Ox, the ſame will ſwell before your Finger; and if you make an Inciſion in it, there will come out a viſcous Liquor like Turpentine. Which Experiment having been ſeveral times proſecuted by

by *Bergerus*, and always appearing in the ſame manner, it puts the ſaid Hypotheſis out of all Doubt.

Sect. IV. *Convictions from the foregoing Obſervations; and an Experiment about Motion.*

I Would ask any Body now, that underſtands this, whether it can ſeem credible to him, that it is brought about by Chance only, and not for any Wiſe Purpoſe, that a Humour, which is ſeparated from the Blood in the Brain, is derived into every Part of the Body, by ſuch an innumerable multitude of Tubes and Channels, in order to produce Motion wherever it is requiſite? To ſay nothing here of the Fermentation of the Food, of Nouriſhment, and ſo many other Uſes, which render the Courſe of this Nervous Juice entirely neceſſary: And can it be without an End, that this Humour has one wonderful Property, (more we cannot reckon here with any Certainty) that it is fitted, together with the Blood of the Arteries, to produce theſe Motions in the Muſcles?

For that the Arterial Blood does likewiſe very much contribute to Motion, may appear from the Experiments of *Bartholinus*; by which we ſee, that a Limb or Joynt is render'd lame and void of Motion, as well when, by Binding the Artery, the Blood is hinder'd from coming into the Muſcles, as when the ſame is done to a Nerve. And can any one obſerve this come to paſs, after ſuch an amazing manner, not only in one, but in all Men and Beaſts too, and ſo many Wonders produced thereby; ſuch as the external Motions of Walking, Swimming, Flying; and the internal, of the Heart, Arteries, Stomach, Bowels, and ſo many other Parts, ſerving both for the Support and Procreation of Animals; and, can he then

aſcribe all this to mere Chance and ignorant Cauſes, without thinking that he will be taken, by all wiſe Men, for a blind or obſtinate Fool?

Sect. V. *The Nerves of Hearing are extended likewiſe to the Tongue.*

Now let a Man conſider farther with himſelf, whether the Great End of our Creator, to furniſh us compleatly with every thing that is neceſſary for us, does not plainly appear in the following Caſes: *Firſt*, That the Nerves of *Hearing* do diſtribute their Branches to the Muſcles that move the Ear, to the end, that as ſoon as we are warned by the Noiſe which affects the Nerve, the other Inſtruments may be immediately put into a Condition of erecting the Ear, in order to liſten the better: This is obſervable in the raiſing the Ears of many Creatures as ſoon as you ſpeak or call to them; for the ſame Reaſon it is, that this Nerve ſends other Branches to the Eyes alſo, that upon the hearing of any uncommon Sound, we may preſently look about us; and likewiſe, be ready, without delay, if ſpeaking or calling for Help be neceſſary; for which purpoſe, the ſaid Nerve of *Hearing* has a Communication with thoſe of the Fifth Pair, and the Parts that produce Speech.

Sect. VI. *The Nerves of Taſting.*

Secondly, That the Nerves which ſerve to produce *Taſt*, and which, according to *Willis*, make a fifth and ſixth Pair, do likewiſe ſend out Branches to all thoſe Inſtruments that are neceſſary for Maſtication or Chewing, to render the Action and Taſt lively and ready; they likewiſe ſend other Branches to the Noſe and Eyes, to the end, that in the Choice of our Victuals, we may be aſſiſted by

the Smell and Sight: And laſtly, that while all the forementionʼd are exerted, to the end, that nothing may be wanting, other Branches are tranſmitted to the Glands for Spittle, that this Humour may be ſupplied in abundance, and the Mouth and Throat moiſtenʼd therewith, during the Action of Chewing and Taſting.

Sect. VII. *Nerves that Operate with, or without our Conſent.*

Thirdly, Can any one ſee without Aſtoniſhment, that Nerves, which ſeem to be made of the ſame Matter, and maintained by the ſame Food, can perform ſuch various and different Functions? That the firſt, which comes out of the Marrow of the Back, as the ſaid Marrow does from the fore-part of the Brain, ſhould entirely be governed by our Will, in the Motions produced by it in our Arms, Legs, *&c.* and accordingly cauſe the Muſcles to operate, or to ceaſe Working; whereas the other, that have their Origin in the *Cerebellum*, or Hinder-part of the Brain, do continually and inceſſantly move thoſe Parts to which they are tranſmitted, as long as our Life laſts, without the leaſt Subjection to our Will.

Sect. VIII. *The Par-vagum and Intercoſtal Nerves.*

We ſhall give a Proof hereof, in *Tab.* IV. *Fig. 6.* which, by reaſon of its Smallneſs, can only ſhew us a little of it: A B is the *Par-vagum*, or Wandering Nerve, as it is called by the Ancients, becauſe it is extended to ſo many Parts; by *Willis* it is called the Eighth Pair; of this, A repreſents the uppermoſt *Plexus*, and B the following; after ſome Ramifications to the Muſcles of the Throat and Neck, there goes out of H, a Branch *a*,

to the upper-part of the Wind-pipe, there come ſeveral other from B, which extend themſelves to the Heart, to the *Pericardium*, and to its Auricles and Blood-Veſſels, and one bigger than the reſt, C, which runs to the *Plexus Nervoſus* of the Heart F; from the *Plexus* B, there ſprings likewiſe the recurrent *Nerve* D on the right Side, and E from the Body of the Nerve itſelf on the left Side, which moves the Wind-pipe.

Beſides theſe, there goes at *e*, a Great Branch to the Vein of the Lungs, and to the Heart at D, and from the *Plexus Nervoſus* of the Heart F, runs a Branch *e*, to the Artery of the Lungs, and a great many, *f*, to the Heart.

Moreover, there paſs from this Nerve a great many Branches *g*, to the Lungs, and the Veins and Arteries, and *Bronchi* of the Lungs in the ſame, and ſome, *h*, to the Gullet.

Finally, this ſame Nerve divides itſelf into two Branches, G H, on each ſide, which afterwards uniting again in I, ſpreads an unſpeakable number of Branches in the Stomach; and, after having ſent ſome Sprigs to the *Plexus Nervoſus*, lying in the Belly, ends there, as far as we have been able to diſcover.

The fifth and ſixth Pair of Nerves (marked 5 and 6) the firſt of which does in a manner furniſh all the Parts of the Face and Mouth with Nerves, make a great Nerve by the Branches which they ſend out, and which are commonly called, tho' not very properly, the *Intercoſtal*; this, after having made a *Plexus* above at *i*, and tranſmitted out of it a Branch to the contracting Muſcle of the Gullet, proceeds forward to a ſecond *Plexus* K, which lies in the Neck; and after having ſent out of it ſome Fibres λ, to the Gullet and Wind-pipe, communicates farther Great Branches L, to the *Plexus Nervoſus* of the Heart. Again, this ſame Nerve makes

makes a third *Plexus* at N, and then deſcends thro' the Breaſt, where ſome Nerves, *n n*, are inſerted therein from the Back-bone; and coming into the Belly, tranſmits two Great Branches, *p p*, downwards, which makes other *Plexus* at S T U *u*, and from thence communicates Nerves to all the Inteſtines of the Belly, as may be ſeen in W, paſſing to the Bowels.

To conclude; There are none of the Entrails either in the Breaſt or Belly, but what receive Branches from the two Nerves we have here been deſcribing; *viz.* the *Vagus* and the *Intercoſtalis*. Whoſoever deſires to ſee them minutely repreſented, may conſult the famous Works of Meſſieurs *Willis* and *Vieuſſens*; whoſe Figures from Branch to Branch, together with the Courſe of the Nerves in the Body, before they were Publiſhed, were compared and examined by another great Anatomiſt, being founded upon Experimental Diſſections of above 400 Bodies in the ſpace of fifteen Years.

One might here make infinite Remarks upon each Duct, or Courſe, of theſe Nerves; upon their Inſertions into one another; upon the ſeveral Parts which receive their Nerves from the ſaid Branches; upon the *Plexus* that appears therein, and which conſiſt of the Concurrence of many Nerves of a different Original; as at F, for inſtance, which is equally compoſed of the Sprigs of the *Par-vagum* and *Intercoſtale*; to the end, that the Heart, which is thereby moved, might receive its Nervous Juice from the one, in caſe the other ſhould fail: To ſay no more, can any Body imagine, that theſe Diſpoſitions have been made without Wiſdom?

Sect. IX. *Convictions from the foregoing Obſervations.*

I Cannot forbear putting this one Queſtion to a Man, that is ſtill ſo unfortunate, as not to be able to diſcover from all theſe things, the Wiſdom of his Creator; *viz.* Whether he can, without trembling, conſider, that all this Great Compoſition of the *Wandering* and *Intercoſtal* Nerves, by which his Heart, Lungs, Veins, Stomach, Guts, Liver, Kidneys, and every thing elſe, that contributes to the ſupport of his precious Life, are moved, is performed entirely without his own Will and Concurrence? And, that there is ſcarce any thing elſe left to him, beſides the command over thoſe Nerves which ſerve for its External Functions; whilſt, in the mean time, he is not able to continue one ſingle Inſtant the Action of thoſe Nerves by which he lives. Nor can the moſt obdurate *Atheiſt*, or the *ſtrongeſt Mind* (as they love to call themſelves) find here any Evaſion to ſatisfie his diſturbed Conſcience, that he is not abſolutely in the Hands of another, upon whom his Life does continually depend; at the ſame time that he is forced to confeſs, from his own Experience, that all the Motions contributing thereto, are produced in him, without, and againſt his Will, by Nerves, whoſe Operations he can neither directly obſtruct, nor promote.

Sect. X. *The unhappy Condition of the Atheiſt.*

How much more happy then is ſuch a one, who from Contemplating the Diſpoſition and Structure of his Nerves, and the Conſequences thereof, has learned to know himſelf ſo far, as to be experimentally convinc'd, that his gracious Creator has cauſed all

all the Nerves which ſerve for the ſupport of his Body, for the Motions of his Heart, Lungs, Stomach, *&c.* for the Circulation and Separation of his Humours and other Neceſſaries of Life, to operate for the reſpective Purpoſes, by an immediate Power; and not only without his Will, but even without his Knowledge, or any Perception thereof? And who having farther obſerved how many Nerves, by the Wiſe Providence of his Maker, are ſtill left for the moving of other Members, according to his own Diſcretion wholly; I ſay, who is there, that after having ſeriouſly conſider'd all theſe things, does not find himſelf obliged to uſe them all to the Honour and Glory only of his adorable Creator?

Sect. XI. *The Nerves of the Midriff.*

And if this be not ſufficient to convince every Man of the Views and Deſigns of a Wiſe and Merciful Creator, in the Diſpoſition of the Nerves, let him caſt his Eyes upon *Tab.* IV. *Fig.* 7. in which he will find the Repreſentation of the Midriff, which we have cauſed to be drawn for this purpoſe only.

Now to ſay nothing of its Circular Muſcle A A, and another B, its Tendinous Part C, the Paſſage D for the Gullet, and E for the *Vena Cava*; as alſo the Blood Veſſels that feed it, G H I; of which every Body that underſtands their Uſes, can ſay a great deal more, in order to prove the Wiſe Deſigns and Purpoſes of the Great Creator: Can any one be ſo blind, who knowing how neceſſary it is, that the Motions of the Midriff ſhou'd depend upon our Will, when in extraordinary Breathing, in Singing, Speaking, and other Incidents, the ſame is requiſite, obſerves here, that two Nerves K K, iſſuing out of the Nerves of the Neck (as they do from

the *Medulla Spinalis*) and therefore do belong to thoſe that are ſubject to our Will, are beſtowed upon the ſaid Midriff? And when he is moreover convinced, that it is no leſs neceſſary that the great Work of Reſpiration ſhould be continually carried on, even whilſt we ſleep; and how inconvenient it would be, that whilſt we are waking, if we happen to fix our Thoughts upon other Matters, we ſhould be obliged every time to attend to the Buſineſs of Reſpiration, and to divert our Thoughts from all other things to this alone: Can a Man, I ſay, without acknowledging the gracious Purpoſe of his Maker, obſerve that two other Nerves, L L, are communicated to the Midriff, which (as it happens alſo to the Bowels, Heart, &c.) do continue the Motion thereof without our Concurrence, and when we leaſt think of it, and for that reaſon take their Riſe from the Intercoſtal Nerves, which are made for that Purpoſe?

Sect. XII. *The Nerves of the* Inteſtinum Rectum.

The ſame may be obſerved, beſides other Parts, in the *Inteſtinum Rectum*, which requires one Motion ſpontaneous and independent of our Will, in order to bring forwards that which is contained therein; and again, a ſecond Motion, which is voluntary, in order to be exerted with the greater Force at the time of the Diſcharge.

The Words of the accurate Anatomiſt *Verheyen* are very remarkable upon this Occaſion: *The Inteſtines have, among others, their Nerves of the great* Plexus Nervoſus *in the Meſentery, and all of them are ſerviceable to the Motions performed without our Will* (Functiones involuntariæ.) *But the* Inteſtinum Rectum, *and probably alſo that Part of the Gut that is immediately joining to it, has other Nerves from the lower Part of the* Medulla Spinalis, *by the help of which*

which the Diſcharges of the Belly are performed, according to, and in conſequence of our Will.

Sect. XIII. *The* Vaſa Lymphatica.

Now as the Blood which goes thro' the Arteries to the Parts of the Body is brought back again thro' the Veins, the Enquirers into Nature have likewiſe aſſerted, and not without great Probability, that the Humour which is ſeparated from the Blood in the Veins, and which is communicated by the Nerves to all the Parts, is brought back alſo by another ſort of Veſſels (called the *Vaſa Lymphatica*) to the Blood, and ſo performs as it were another Circulation.

Now whether this *Lympha*, or tranſparent Liquor, proceeds from the ſmalleſt Side Branches of the Arteries, in each of which at the ſame time a Nervous Sprig diſcharges itſelf, we ſhall not here farther examine, but refer ſuch as deſire to know it, to the ſecond Work of Monſieur *Vieuſſens*: This is true at leaſt, that theſe *Vaſa Lymphatica* are obſerved to proceed from all the Parts of Creatures (the Brain excepted, that being yet doubtful) as likewiſe that the Courſe of their Liquor in *q q* (*Tab.* I. *Fig.* 6.) proceeds to the *Ductus Thoracicus* O *r r*, and ſo to the *Vena Subclavia*, *u x*, and other Places directly to the Veins; that they have innumerable little Valves, in order to prevent the Return of the ſaid Liquor, and ſo appear like Links of little Chains *q q*; that they touch upon ſeveral Glands in their Paſſage, or proceed likewiſe from ſome. Thoſe who deſire to have any Notion of this Matter, may conſult *Tab.* IV. *Fig.* 8. where it is ſhewn how theſe *Vaſa Lymphatica* L L L, &c. coming out of the Kidneys B B, and other Parts of the Body, have a Communication with the Glands F, G, H, I, K, and diſcharge themſelves

ſelves into the Receptacle of the Chyle D, in orde to carry their Liquor on to the Blood by the *Ductus Chylicus* E, which is here repreſented as cut of and in the mean time (as we have ſaid above) hel to make a Stream for the Circulation of th Chyle.

Now how unknown ſoever may be the tru Source or Origin of theſe Veſſels, foraſmuch a moſt of the Experiments have been made upo Beaſts, and deſcribed from them, the Opportuni ties being very rare of opening Men ſo quickl after their Death, in order to diſcover theſe Veſ ſels which do preſently diſappear, for which rea ſon ſome principal Anatomiſts have endeavoured to ſhew their Courſe by injecting Quickſilver, pre pared for that Purpoſe, into them; yet this at leaſt is true, that they do diſcharge all their Li quor into the Venous Blood, and ſo render the aforementioned Service to the Chyle.

Sect. XIV. *The Glands.*

We ſhall paſs over the Diſpoſition and Structure of the Glands, it being ſtill ſubject to too many Differences and Diſputes in the chiefeſt Matters, but which perhaps may furniſh Poſterity with new Matter to convince the Unbelievers, of the Wiſdom of their Creator; however it appears in the mean time plain enough, that they cannot attribute it to *mere Chance*, or *ignorant Cauſes*, that the ſaid Glands are uſeful to ſo many, if not to all the Separations of Juices; and that this wonderful and as yet unknown Effect, is produced in their Bodies, *viz.* that the Blood (which in it ſelf is in a manner inſipid) being brought into the Glands by its Veſſels, the Humours that are ſeparated from it in thoſe Glands, are thereupon impregnated with ſo many different Taſts and Properties.

Thus,

Thus, that which is ſeparated in the Kidneys is Salt, as are likewiſe the *Tears* and the *Sweat*, which proceed from the Glands of the Eyes, or comes out of the Pores of the Skin; from the Liver there iſſues a bitter Gall; from the Glands of the Breaſts of Females, a ſweet Milk; from the *Glandulæ Salivales*, Spittle, *&c.*

Now every body knows, that upon the Obſtruction or Ceſſation of any of theſe Humours, grievous Sickneſſes and Death itſelf does ſometimes follow, and that almoſt all of 'em, how different ſoever their Nature be, are abſolutely neceſſary to Health or Life. The Nerves likewiſe, and the Arteries, which carry the Blood and the Nervous Juices thereto, or diſcharge themſelves therein; the Veins and Lymphatick Veſſels which bring back the Blood and *Lympha*, or what is ſeparated from thence, and which contribute to a Paſſage or Way for the ſeparated Juices, where they can be uſeful in ſo many particular Veſſels already diſcovered; I ſay, all theſe things do abundantly inſtruct us, that each of 'em are formed for a particular End, and are therefore placed exactly where they can be moſt ſerviceable; the rather, ſince Anatomiſts have diſcovered (See *Vieuſſens* in 8*vo*, p. 238.) that altho' there is little Motion or Senſation in them, yet, in reſpect of their Bigneſs, more Nerves are found in them, than in any other part of the Body.

Sect. XV. *The Membranes.*

Much might be here ſaid about the Membranes, and which would powerfully ſupport our Deſign, eſpecially if we ſhould here propoſe all the modern Diſcoveries that ſeem to be only in their *Embryo*, and have not yet attained their

their full Perfection; this is certain, that they have the following Uſes:

1. That they ſerve to cloath or cover ſome Parts, as may be obſerved of the *Pleura* in the Breaſt, and of the *Peritonæum* in the Belly.

2. To form Tubes and Veſſels, as in the Blood, and Lymphatick Veſſels and Inteſtines.

3. To join or faſten ſome Parts together; thus are the Inteſtines faſtened to each other by the Meſentery, and both together to the Back.

4. To divide Cavities into more Parts; thus the *Mediaſtinum* divides the Breaſt into two Spaces, under which Head we may likewiſe reduce the Membranous Valves in the Heart, Veins, Lymphatick Veſſels, *&c.*

5. Not to reckon that they are by many eſteemed to be the true Inſtruments of Feeling, and perhaps of other external Senſes.

6. There is yet a greater Service performed by them, *viz.* That many of 'em conſiſt of Muſcular Fibres, which by their Contraction or Squeezing, when they make Tubes or other Cavities, are proper to protrude that which is included in thoſe Membranes; as we ſee it happens in the Stomach, Guts, Bladder, Arteries, and the like.

Sect. XVI. *The* Dura Mater, *or thick Membrane of the Brain.*

Monsieur *Pacchionus* ſhews, that according to *Anatomical* and *Practical Obſervations*, the thick Membrane of the Brain, commonly called the *Dura Mater*, has the ſame Property of protruding the Humour ſeparated in the Brain into the Nerves; and ſince this Membrane does inveſt all the Branches of the Nerves, how many ſoever they be, he thinks it is very probable that by a Contraction of its Fibres (like that of the *Periſtaltick Motion*,

Motion, which happens in the Inteſtines) the Humour is driven forth into the Nerves; I leave this Matter to farther Enquiry; but if one may here mention that which ſeems very likely concerning it, I ſhould think, that unleſs ſomewhat of that Nature did occaſion the Protruſion of the Nervous Juice, ſuch a Power or Faculty could not be deduced only from the Motion of the Heart; foraſmuch as the Matter of which the *Medulla Spinalis* and the Nerves are compoſed, does not ſeem proper to afford a ſwift and ready Paſſage to ſuch a tough and Turpentine-like Humour, as the famous *Malpighius* deſcribes it to be. Moreover, it ſeems to be a neceſſary Conſequence, that in caſe the Heart were the only, or chief Cauſe of the Nervous Juice, a Nerve being tied or bound, as is uſual in Arteries and Veins, would ſwell up againſt the Band, which many who have made this Experiment complain does not happen; but if the Contraction of the *Dura Mater*, which encompaſſes the Nerves, does, without any viſible Aſſiſtance from the Heart, alone protrude this Humour, every body muſt own that this *Periſtaltic Motion*, by the Compreſſion of a String or Band, would be forced to ceaſe; whereupon, that which we experience would follow, *viz.* that the Nerves would not be able to ſwell and expand themſelves by the protruded Matter againſt the Band.

For a further clearing of this Matter, I could have added ſome Practical Caſes, which, without the Hypotheſis of ſuch a Motion in the Nervous Membranes, would ſeem unintelligible, and yet, being handled upon this Foundation, meet with the deſired Succeſs, after having tried ſeveral other Means in vain. But this is not a time to ſpeak of theſe Things here; let every one conſider and reflect by himſelf, whether upon ſeeing the known and undeniable Uſes of the Membranes, he muſt not

not acknowledge and be convinced of the Wiſdom of his Creator.

Sect. XVII. *The Flexibility of the Membranes.*

To ſpeak ſomething of this Matter: Foraſmuch as it was neceſſary for the Support of Life, that the Blood and Nervous Juice ſhould be carried to all the Parts of the Body, and brought back again, it was no leſs neceſſary that Veſſels, ſuch as the Arteries, Veins, Nerves, and thoſe belonging to the *Lympha*, ſhould be formed for that Purpoſe: But ſince, beſides this, the Body was to be moved, and that therefore Inflections and Angles were to be made in its Joints, it ſeemed requiſite that theſe Tubes ought likewiſe to be flexible, to the end that (for Inſtance) the Arteries in the Arm and Hand might ſerve for a Paſſage to the Blood, as well when they were bent at the Elbow or Fingers, (at which time ſo many Angles and Inflections are produced,) as when the ſame Arm or Hand being ſtretched out, the ſaid Tubes were likewiſe extended in right Lines.

We ſhall paſs by other Remarks concerning the abovementioned Glands and Membranes, having dwelt long enough already upon 'em; as alſo all that might have been added farther upon many other Matters, ſuch as the Ligaments or Bands by which the Bones are joined together; of the Fat, Skin, *Cuticula*, and the like; thoſe who have a Mind to examine into what is already diſcovered thereupon, will find Cauſe enough to extol the Wiſdom and Goodneſs of the Creator.

CONTEM-

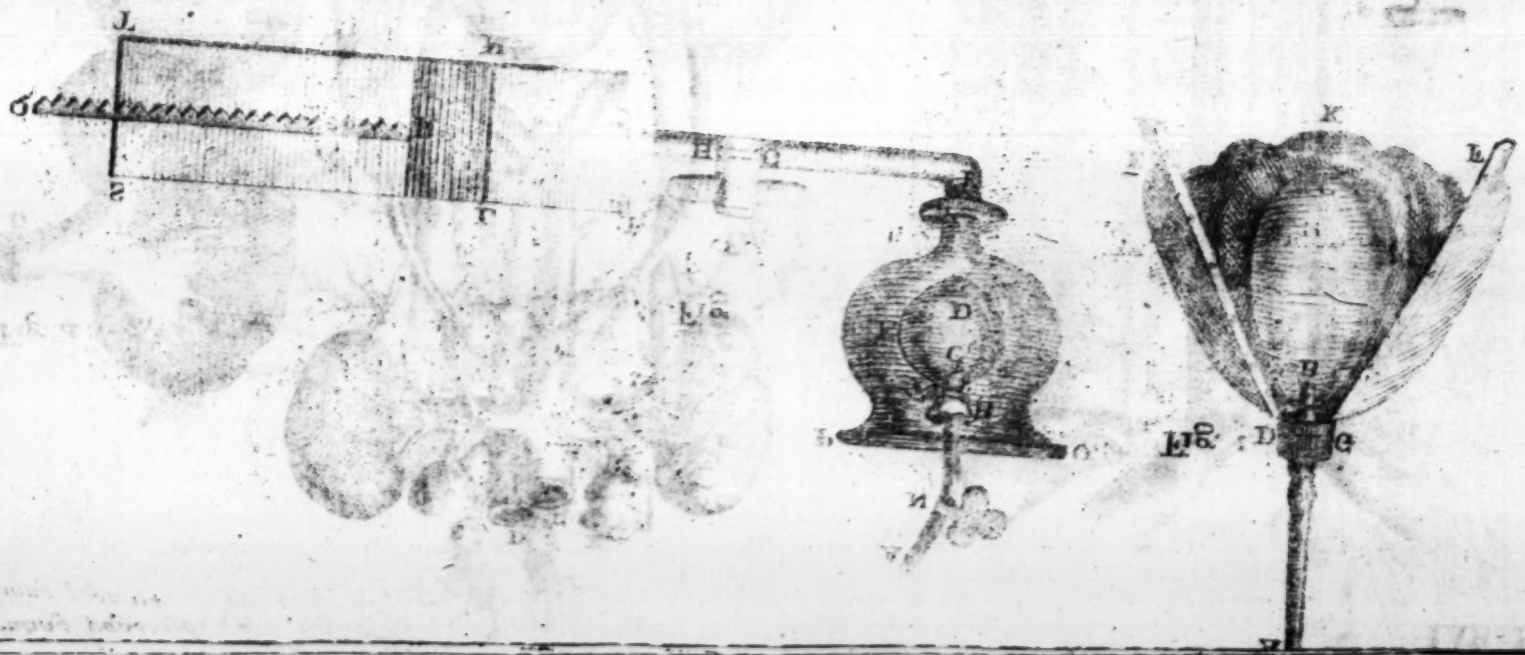

J
K
L
H
D
C
B
G
F



Fig. 4



Fig. 5



Fig. 3

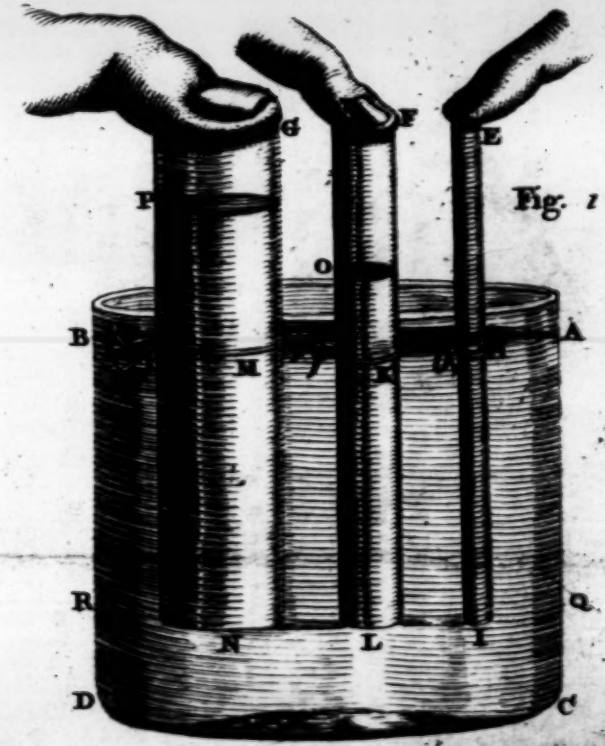


Fig. 1

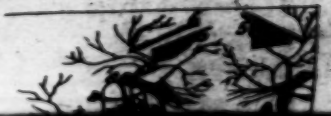


Fig. 2

Fig. 2

Fig. 8

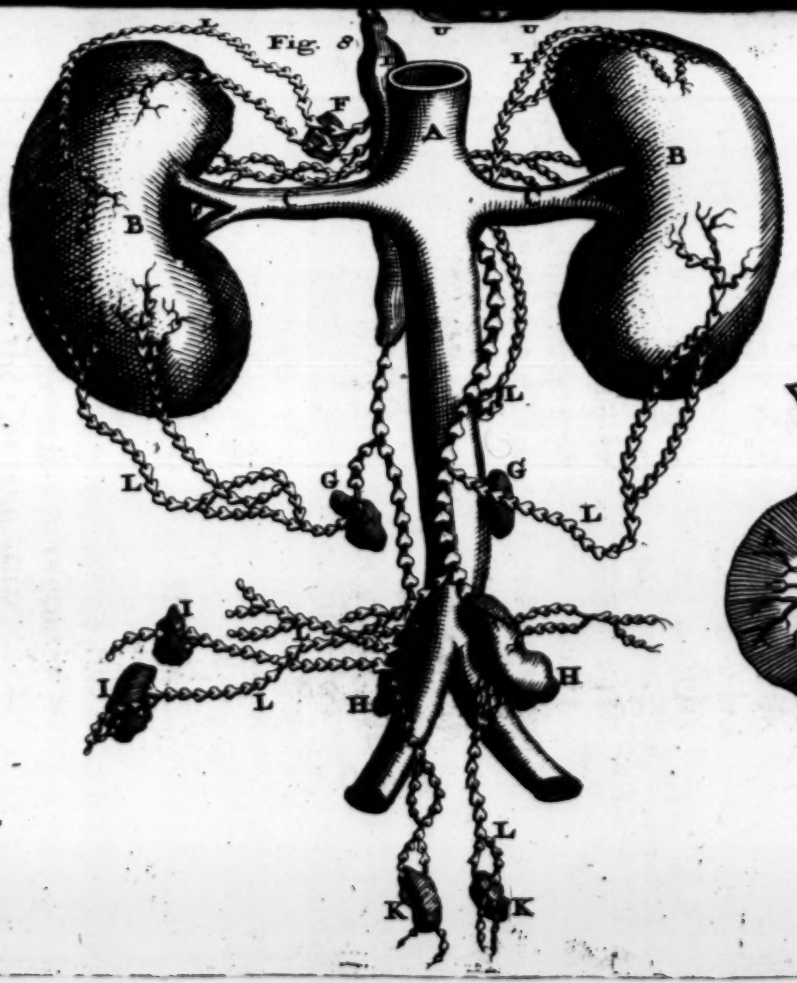


Fig. 6



Fig. 7





CONTEMPLATION X.

Of the Muſcles

Sect. 1. *The Tranſition to the Muſcles.*

NOW in caſe that the foregoing ſhould not appear ſufficient to convince every Man fully, and entirely, of the great Ends of his Creator, and of the moſt wiſe Manner of executing the ſame; (tho' not hardly to be ſuppoſed, of ſuch as have thoroughly comprehended what we have already repreſented to them thereof) yet, at leaſt, this great Truth will appear to be placed beyond the reach of all Doubting, by the ſingle Enquiry only into the wonderful Compoſition of the Muſcles of a Humane Body; which Muſcles are, in a manner, the Inſtruments of all its Motions. And, in caſe any Body ſhould view, with an underſtanding Eye, the Inſertion or Faſtening of the ſame to the Bones (which are likewiſe ſo exactly adapted for the making of Limbs and Joynts, whereby Motion may proceed without Interruption,) their wonderful Contexture, and the amazing Power and Strength communicated to them, tho' conſiſting of ſuch exceeding fine and ſlender Fibres or Threads; I ſay, whoever contemplates any of theſe Particulars, muſt needs acknowledge in all of 'em, the Hand of a Great and Mighty, Wiſe and Good Creator; the rather, becauſe he has an Example thereof in the greateſt Philoſophers and Mathematicians, whom the Contemplation of theſe Wonders

Wonders, and the Enquiry into the Wiſdom that ſhines out of them, have often compelled to acknowledge the Glory of GOD in theſe his Works. For one Inſtance, amongſt a great many others, one need only peruſe the Dedication of that Book that Monſieur *Borelli* publiſhed, about the *Motion of Animals.*

SECT. II. *Of the Muſcles in General.*

NOW not to ask whether any Body, that underſtands never ſo little the Structure of Muſcles, could believe, that thoſe which move the Tongue, or the Hands of a Man (to mention no more of 'em) are made without *Deſign*, without *Wiſdom*, and by *Chance* only; and that all the ſo neceſſary and uſeful Functions, performed by them in the Bodies of Men, are produced by ignorant Cauſes: Can it be imagined, that the Power and Goodneſs of our Great Creator does ſo far extend itſelf towards us, that the Muſcles in a Man's Foot have been adapted by him, to ſerve upon occaſion, in the ſtead of Hands? And yet, as ſtrange as this may ſeem to be, we have ſeen, not long ſince, a Man, who being born without Arms, could uſe his Feet almoſt for all Purpoſes, and among others, write a fine *Italian*, Character with the ſame, as faſt and as accurately, as another good Writer was able to do with his Fingers; to ſay nothing of many other of his Motions, ſuch as ſhuffling of Cards, and playing therewith, and managing a good Number of them ſo dexterouſly, that he could not have done it better if he had had the uſe of both his Hands: Now in caſe thoſe Muſcles that move the Feet, had not been of proper Structure for the like Purpoſes, it would have been impoſſible that he could have performed all this with his Feet.

SECT.

Sect. III. *The Deſcription of the Muſcles.*

However, to enquire a little more cloſely into the Structure and Diſpoſition of the Muſcles, and to repreſent the overflowing Wiſdom of our adorable Creator, by ſome few Obſervations upon the ſame, let us contemplate *Tab.* V. *Fig.* 1, 2, 3. which will give us a Sketch of the External Structure of ſome of the Muſcles, the Great and Principal Inſtruments of all our Motions, and by which alone we exert our Strength.

1. A Muſcle then (not to mention here its Artery, Vein, Nerve, and Lymphatick Veſſels, which are repreſented in *Tab.* V. *Fig.* 1. *a b c* tied together) does conſiſt of a Number of fleſhly Fibres or Threads B, running parallel moſtly, and at equal Diſtance from each other, and faſten'd at Top and Bottom to a tough Body, called a Tendon, A and C.

Acroſs theſe fleſhly Fibres B, there run others EF, which are likewiſe Tendinous, Nervous, or Membranous; but as ſlender as ſome of 'em are, they are all very Tough, and not eaſy to be broken, and are regularly interwoven with fleſhly Fibres.

Now in caſe the Tendon A, the Fibres whereof are here ſhewn to be a little ſeparated from each other, be faſten'd to a Bone that is unmovable; and the other C, to one that is moveable, and can yield to the bending of its Joynt; and afterwards each of theſe Muſcular Threads B, are contracted or render'd ſhorter by any Force, be it what it will; it is plain, that the Tendon C, will draw the Bone that can follow, and to which it is faſten'd, towards the other Tendon A, and ſo will bend the Joynt that lies between A and C.

The Anatomiſts are wont to call the Tendon A, which is faſten'd to the immoveable Bone, and towards which the Motion is made, the *Head* of the Muſcle; and the other C, faſten'd to the moveable Part, the *Tail*; and the fleſhly Threads B, with the tranſverſe ones F E, the *Belly* of the Muſcle.

Sect. IV. *The Strength of the Muſcles conſiſts in their many Fibres.*

2. It appears from hence, that the more Fibres there are in B, or the Belly of of the Muſcle, which being contracted do draw, the ſtronger will be the Action, of ſuch a Muſcle, which is alſo found true by Experience.

Sect. V. *Double Muſcles.*

3. Now to the end that a Muſcle may exert greater Force, it will be neceſſary, that it ſhould conſiſt of a great Number of Fibres B, which may cauſe it to encreaſe very much in Thickneſs, and ſo fill that Place, in which other Muſcles, ſerving for other Purpoſes, might have been lodged.

Can any Body then, without Amazement, reflect upon the moſt Ingenious Manner which it has pleaſed the Wiſe and Gracious Creator to uſe, ſo to diſpoſe many more Fibres in the ſame ſpace, in order to make the Muſcle ſo much the ſtronger, that there ſhall not be requir'd much more Room to place thoſe Fibres? *viz.* by leaving to a kind of Muſcles, that are neceſſary in producing a ſtronger Motion than others, the uſual Breadth or Space, but which they are to fill after ſuch a manner as we ſee in *Tab.* V. *Fig.* 2. in which A B C is the Head of the Muſcle or Tendon, faſten'd immoveably at A, and re-

repreſented in this Figure as cut off; E D is the Tail of the other Tendon, that draws the Joint to itſelf; and between both of 'em are two Artful Rows of Fibres F and G, being faſten'd to the Head A B C, and running obliquely to the Tail E D, in which they are inſerted; from whence it appears, that theſe two Rows of Muſcular Fibres, F and G, being forcibly contracted, the Tendon E D, and the Bone faſten'd to it, which is moveable, muſt be drawn towards A, with this Advantage over that which was ſhewn before, in *Tab.* V. *Fig.* 1. that here (*Tab.* V. *Fig.* 2.) many more Fibres, as F and G, can be put in Action in the ſame Space, whilſt they run after this manner obliquely, and as it were acroſs, than when they were extended, as in the former *Fig.* 1. directly only, and at equal Diſtances from each other.

Sect. VI. *Muſcles yet more doubled.*

We may obſerve again, in *Tab.* V. *Fig.* 3. that theſe Muſcular Threads are, after a wonderful manner, upon ſome Occaſions, much more doubled: A is the Head, and B the Tail of the Muſcle, the which laſt B, by two Tendinous Branches that are extended towards A, gives an opportunity for the ranging a much greater Number of fleſhy Fibres in ſuch an exact Order; ſo that the Fibres C and D, being faſten'd to G A H, or the Head of the Muſcle, which is ſuppoſed immoveable, when they are contracted in their Length by any Force, each of them draw their Branch F, and theſe two Branches F and F, draw the Tendon B, and whatever is faſten'd thereto, and is moveable, towards A; which, if it were to be performed by Fibres running directly or ſtreight from A to B, as in *Tab.* V. *Fig.* 1. would, by the great Number of them, compoſe a Muſcle almoſt as thick

as this Muſcle (*Tab.* V. *Fig.* 3.) is long: If what we have here ſaid, does not ſet this Matter in ſo clear a Light as to make it fully underſtood, the Reader may conſult *the Demonſtration of the Force of the Muſcles* SECT. XVII.

SECT. VII. *The Muſcles of the Fingers.*

4. FOR farther Conviction, let us make one only Remark upon ſome of the Muſcles that bend the Fingers; we will therefore conſider the Muſcle A B (*Tab.* V. *Fig.* 4.) as it is faſten'd with its Head or upper Tendon near the Elbow K, and whoſe moving Threads or fleſhly Fibres extending themſelves from B to A, do compoſe the lower Tendon C, and this conſiſting of Four Parts, tranſmits a Branch to each of the remoteſt Joynts of the Fingers, wherein it is inſerted at D. now when the fleſhly Fibres A B, are contracted, the Muſcles being immoveable at K, it is eaſie to obſerve, that the third Joynts of the Fingers D D D D, are thereby drawn towards B, and all the Fingers inflected; the rather, if you ſuppoſe farther, that the Muſcle G F (which is repreſented here out of its Place, and lying above upon A B) is likewiſe contracted in its Fibres F G, and by its four Tendons G E, draws over forwards the ſecond Joint of the Four Fingers.

Now let every one ask himſelf, whether he can ſuppoſe that it is by meer Chance, *Firſt*, that theſe Muſcles A B, and G F, which bend the extreameſt Joints of the Fingers, are placed ſo far above the Hand, and even as high as the Arm, and yet extend themſelves by their long Tendons C D and G F to thoſe Joints which they are to move, ſince, if they had lain in the Hand itſelf, they would have render'd it very unfit for an accurate eaſie Handling of things? Foraſmuch as theſe Muſcles being obliged to exert a great Force, do require

require many fleſhly Fibres, which, when they were contracted and put into Action, would cauſe the Hand to ſwell to a great Thickneſs.

For, that theſe and other Muſcles, ſuch as thoſe deſcribed by A B, do upon their Contraction require a greater Thickneſs, may appear to every one that upon cloſing with ſome Force one of his Hands, and turning it into a Fiſt, does with the other Hand ſpan his Arm below the Elbow; in doing which he will remarkably feel the Muſcles that lie there to be ſwelled: Which Thickneſs, if it were continually produced by ſuch great Muſcles as lie in the Hand, it is plain, would, upon many occaſions, embarraſs it the Exerciſe of its Functions.

Secondly, Whether he muſt not acknowledge, that it is a contrivance beyond the Power of an *Ignorant Cauſe*, that the Tendons G E, of the Muſcle F G, do make a kind of a Door or Opening at E? by which Means the Tendons C D of the Muſcle A B, paſs like a Thread thro' the Eye of a Needle, in oder to hinder theſe laſt in the numerous Motions which the Fingers make upon many Occaſions from being diſorder'd by Diſlocation or other Accidents; or at leaſt, that the Motions of all the Tendons, lying near or upon each other, may not be ſo looſe and uncertain.

Thirdly, Becauſe there would be danger upon the Contraction of the Muſcle A B, that the Tendons C D, which go to all the Joints of the Fingers ſhould recede from the ſame, when they were bent upwards, and occaſion ſeveral Inconveniencies, by ſtretching the Skin too much: Can any one ſee, that each of theſe Tendons is encompaſſed with a kind of a membranous and very ſtrong Sheath, which, without obſtructing their Motion at all, makes it remain faſt to the Bones of the Fingers; not to mention the great Band juſt above

above the Hand, which encircles the Arm in that Place like a Ring, and at once binds together all the Tendons of thoſe Muſcles that go to the utmoſt Parts of the Fingers, preventing them upon great Inflections from receding too far from their proper Places; I ſay, can any one ſee all this, without acknowleding the Deſigns of a Great Creator?

Sect. VIII. *Of the Joints.*

The Joints of a Man neceſſary to produce the Motions between the two Bones C D E, and I B (*Tab.* V. *Fig.* 5.) are moſt commonly of the following Structure; in the firſt, C G E, there is found a larger or ſmaller Cavity C D E, in which the protuberant Part, C D E F, or I of the other Bone is faſten'd after ſuch a manner, that they can both turn and move in each other: Now in caſe this protuberant Part, C D E F A, being Spherical, or round, is exactly adapted to the Cavity C D E, it is eaſie to ſee, that the Bone B A may be moved at Pleaſure upwards or downwards, and on either ſide; but in caſe the ſaid Part, I, were not perfectly a part of a Sphere, but round and flat, like a piece of a Wheel, and then inſerted into its Cavity, it is plain, that the Bone B A might be moved upwards and downwards, but not ſideways.

A Motion analogous to the former, may be obſerved in the Shoulder or Hip; and to the latter in the Elbow or Knee, ſome little Circumſtances excepted, which, in the main, do not alter the Caſe, but ſerve for other Improvements.

Now can the beſt Mechaniſt in the World compoſe or put together any Joints after another manner, whereby ſo great a Force may be produced, with ſo much Conveniency, and ſo little danger of being diſorder'd by Common Motions? Yea, we know that if one Bone turned upon the other

other with a ſharp Point, in uſing any Force or Violence, it might preſently miſs its Support or *Fulcrum* in many Accidents, and the Point run the risk of being Broken, or at leaſt Disjointed: It would likewiſe have been impoſſible, after the ſame manner, for a Bone of any Common Thickneſs, to make ſo acute an Angle as the Elbow does with the Bone of the Arm; nor could the two Bones be in ſuch a Poſition, with reſpect to each other, and parallel with the Length of a Man, as the whole Arm is, when extended downwards on the ſide of the Body, or upwards on the ſide of the Head. In other Forms or Modes of Joints, beſides thoſe which appear in Animals, other Inconveniencies will reſult from them.

To prevent all which, what ſafer Method can be made uſe of to produce the Motion of two Bones, than that which is repreſented in *Tab.* V. *Fig* 5. not by the extreme Point thereof, which might eaſily be broken or diſlocated; but by a Centre I, which you muſt ſuppoſe to be in the middle of the Spherical Protuberance, C D E F A, of the Bone A B, or if it be Cylindrical about the Line which runs length-wiſe thro' the Centre thereof, and of which I is the extream Point, as we ſee it happens in our Joints.

Sect. IX. *The Inſertion of the Tendons.*

Suppose A B, and F G, in *Tab.* V. *Fig.* 6. to be two Bones joyned together, which make a Joint at A F; now if one would bend the Bone A B, at H, and for that purpoſe, only make uſe of the Draught and Contraction of the Muſcle D R E, which is immoveably faſten'd to D in the ſame manner as one moves the loweſt Bone of the Arm, by bending it in the Joint of the Elbow towards the uppermoſt Bone or *Os Humeri*: Let us ſuppoſe firſt, that the Tendon of this Muſcle is

inſerted at E, or cloſe to the Hand in the e
treme Part of the Bone A B, we may then eaſi
bend theſe two Bones upon contracting the Muſc
D E, at the Joint A F: But if the Bone A B, b
brought to A H, in ſuch caſe the Muſcle D E mu
be contracted or ſhorten'd to M D; but if one pr
ceed farther, in order to cauſe the Part H to a
proach yet nearer to D, by the ſame Muſcle, t
whole Muſcle D E, which is now ſhorten'd to D M
will in a manner loſe its Length, and be rolled u
in a Ball or Globular Figure at the Shoulder D
Beſides, that when the Bone A B is raiſed up t
A H, the Skin muſt have ſo much Space or Roo
as to cover the whole Triangle, A H D, unleſs th
Muſcle were naked and looſe from the Arm, as
repreſented in this Figure.

Now if this ſhould happen in many Parts of th
Body, and that more room ſhould be taken up i
the Skin, by other Muſcles that are larger, an
planted in the Bone after the ſame manner; an
ſo make larger Balls or Spherical Figures in th
Places where, by their Contraction, they are rolle
up together, the Body would loſe its Figure a
every Motion by ſuch Expanſion of the Skin, an
upon the ceaſing thereof and Extenſion of th
Muſcles lengthwiſe again, the Conſequence woul
be, that the expanded Skin would hang upon th
Body like a Bag full of Pleats or Wrinkles, to th
end that it might have room enough in its ſubſequen
Motions.

'Tis true, that it ſeems as if this manner o
Inſertion might have been paſſed by, to preſerv
the Beautiful and Noble Structure of a Human
Body, and a Band or Ligament placed at R, t
obviate the receding of the Muſcle from the Bone
So that the Body of the M ſcle it ſelf being then
extended no farther than to D R, a long Tendon
E R, need only be ſtretched to E, and like-
wiſe

wiſe faſten'd to the Joint at its Inflection by the Ligament R, as is ſhewn to happen in *Tab.* V. *Fig.* 4. where there was a particular occaſion for it, namely, that the Hand might not be burdened with too much Fleſh.

But in ſuch a caſe, it cannot alſo be denied, that if all the Tendons were faſten'd to the extreme Part E, of the Bone A B (*Tab.* V. *Fig.* 6.) notwithſtanding that they were kept down by the Ligament R, yet, by reaſon of their Length, they would fill a much greater Part of the Body, and take up more room than they now do, which would not only be unneceſſary, but would likewiſe diſplace ſome other Part.

Not to mention that in this Structure the Tendon R E, running either parallel with both the Bones, G F and A B, or making a very ſmall and acute Angle at E, with the Bone A B as long as the Angle remains ſo ſmall, could not be able to exert much Force in order to raiſe the Bone, tho' drawn with great Violence. That it falls out ſo, in oblique Draughts, the Mechaniſts know very well; and the ſame will eaſily appear by an Experiment in *Tab.* V. *Fig.* 7. if at the end of the Leaver B C, which can turn about an Axis in C, a Force A draws in the oblique line B A, it will not heave up ſo eaſily the ſame Beam, to which a Weight D is hanging, as when this Force draws by a leſs Obliquity (in the line B E,) the Beam and Weight upwards. Wherefore the Muſcle (*Tab.* V. *Fig.* 6.) working in the Angle D M C, on the Bone in H, will perhaps, with the ſame Force, do Eight or Ten times more than at the beginning with the Angle D E C.

With how much more Advantage then has the Great Creator of Mankind been pleaſed to direct this Inſertion of the Tendons in the Bones, after

after ſo wiſe a Manner, that not only all theſe Inconveniencies are thereby prevented, but likewiſe the Spaces, which would be otherwiſe filled by the exceſſive Lengths of ſo greatly extended Tendons, may with much Eaſe be employed in receiving other Parts that ſerve for farther Purpoſes.

For this End it has pleaſed him in his Wiſdom to place little Eminences at the extream Parts of the Bones, and thereby to render them thicker and ſtronger in that Part, and to inſert the Tendons near or in the ſaid Eminences, or cloſe to the Joints in the following Manner:

Let A B and F G (*Tab.* V. *Fig.* 8.) be two Bones, making together a Joint at A F G, which is moveable at the Point C, ſo that both of 'em at their Extremities I K A F are globular, and thicker than their Tubes: Now the Muſcle D E K I is inſerted at I, cloſe to the biggeſt Knob of the Bone B A; ſo that it turns about the Eminency K I, like a Rope in a Pulley, if we may be allowed to give ſuch a courſe Idea of it.

SECT. X. *This Inſertion of the Tendons prevents all Inconveniencies.*

WE need not then take much Pains to ſhew that by ſuch a Method all the aforementioned Inconveniencies are removed; foraſmuch as, *Firſt*, the Tendon being inſerted at C (*Tab.* V. *Fig.* 6.) and not at E, when contracted towards D, cannot make ſuch a Triangle as M C D, and conſequently don't ſtand in need of ſo much Room in the Skin for its Motion. *Secondly*, the Muſcle D E K I (*Tab.* V. *Fig.* 8.) being inſerted in or near the Thickneſs of the Bone, in order to produce a great Velocity at B, the extreme Part of the Bone A B, ſuch as from B to M; it needs only inflect the Point I, in a very ſhort Segment of a Circle to K; for which

Reaſon

Reaſon likewiſe the Muſcle requires very ſmall Contraction; nor is it requiſite that the whole Length ſhould be rolled up in a Globular Figure; and thus, the Muſcle being grown but very little thicker by ſo ſmall a Contraction, the Body loſes nothing of its Figure and Beauty; whereas otherwiſe, if the Tendon were inſerted in the extreme Part of the Bone (as at E, *Tab.* V. *Fig.* 6.) the ſaid Body, ſuppoſing the ſame ſhould happen in all its Parts, would for both theſe Reaſons become very monſtrous. *Thirdly*, We may likewiſe ſee here, that the whole Length (*Tab.* V. *Fig.* 8.) remains free from I to B, without being filled by the Tendon of this Muſcle D E K I, and ſo there is a Place left for other Parts and other Uſes. *Fourthly*, The Mathematicians know, that when the Muſcle at K, fix'd to the Knob or Thickneſs of the Bone F A I K, performs its Function after the manner of a Pulley; the Line K C, which extends itſelf from the Centre C to K, on account of the Roundneſs of the ſaid Knob, is always nearly of an equal Length; and therefore when the Muſcle is contracted with equal Force, it always exerts the ſame Strength when it proceeds to lift up the Bone A B; in which, it has been already ſhewn, at *Tab.* V, VI, VII, there would have been a great Inequality on account of the changing the Obliquity of the Angles, had it not been for this manner of Inſertion.

Sect. XI. *A Muſcle exerts a greater Force againſt a ſmaller Weight.*

It is true that the Muſcle D K (*Tab.* V. *Fig.* 8.) acting with a ſhorter Purchaſe or nearer the Center, as by the Diſtance C K, and the Weight againſt it with a longer C B, the Power of the Muſcle muſt be ſo much greater than that of the Weight; and

and that it ſeems to contradict the Cuſtom of Men in making Inſtruments to raiſe up a greater with a ſmaller Force, ſince all their late Diſcoveries in Mechanics in the ſeveral Engines for Motion, ſuch as Balances, Leavers, Pullies, Wheels, inclin'd Plains, and Screws, &c. ſeem to have a contrary View, that is to ſay, by a ſmaller Power to move a greater Weight, which Weight they therefore hang upon the ſhorteſt Arm.

But no body will be able to deny, *Firſt*, That in the Motion of the Muſcles, all the Inconveniencies already enumerated, are avoided by this Diſpoſition which requires a greater Force in the Muſcles.

Secondly, That in the common Mechanical Inſtruments, where a greater Weight is raiſed by a ſmaller Power or Force, the Motion of the Weight is always much ſlower than that of the Power; and that if it be required to raiſe the ſame Weight with greater Velocity or Quickneſs, the readieſt Way, the Power muſt be applied to the ſhorter Arm, and the ſame proportionably increaſed in Greatneſs only, without being obliged ſcarcely to augment the Velocity thereof in this Caſe, which would otherwiſe be neceſſary.

Sect. XII. *The Reaſon why a greater Force is made uſe of by the Muſcles againſt a ſmaller Weight.*

If this Matter does not appear yet clear enough to every one, let them imagine that the Muſcle D K I (*Tab.* V. *Fig.* 8.) does by its Force move the Knob of the Bone K I A F from V to K, by which means the Point B is at the ſame time raiſed to M, and therefore acquires ſo much more Velocity than the Point U or I, upon which the Force of the Muſcle operates, as the Arc B M, or the Arm B C, is ſo many times longer than the Arc K V, or the Arm K C; and therefore the Muſcle itſelf

itſelf will be but a very little contracted, as it is plain to every one that conſiders this Matter.

Sect. XIII. *Convictions from the foregoing Obſervations.*

Now can any body that judges impartially forbear obſerving here, that the great Force of the Muſcles which is required in exerting their Motions in the abovementioned manner, is ſo far from a Diminution of the Wiſdom of the Creator, that, on the contrary, it ought to be an Occaſion of Thankfulneſs to every reaſonable Perſon; foraſmuch as their gracious Creator has been pleaſed, in augmenting the Force of the Muſcles, to cauſe them to operate in ſo eaſy and almoſt inſenſible a Manner, with ſuch little Contractions, and yet at the ſame time to make them produce the Motions of the Limbs upon which they act, with ſuch an unequally greater Swiftneſs?

Sect. XIV. *The very great Strength of the Muſcles.*

Ask an Atheiſt, ask a Sceptick, ask a great Mathematician and Philoſopher, ask all Men without Diſtinction, and let them ſay if they can, after what manner in ſuch tender Threads of Muſcles, as are thoſe of which the Fleſh of Men and Beaſts is made up, a Faculty is lodged, by which, upon their contracting themſelves, ſuch a ſurpriſing Force can be produced, as is exerted by them in their Motions.

And let no body think that we are ſpeaking Hyperbolically to magnifie the Matter, or to excite their Aſtoniſhment: For,

Firſt, Can any one believe, if it had not been demonſtrated by that great Mathematician *Borelli*, *Par.* 87, 88, and 127, that when a Man lifts up with

with his Mouth a Weight of near two hundred Pound with a Rope faſtened to the Jaw-Teeth (which, according to him, has been done even as far as to three hundred Weight) that the Muſcles named the *Temporalis* and the *Maſſeter*, with which People chew, and which perform this Work, do exert a Force of above 15000 Pound Weight?

Secondly, Can any one ſee without Aſtoniſhment that when the Weight R (*Tab.* V. *Fig.* 9.) of fifty five Pound is held up in *Equilibrio* by the Elbow B, of the Arm A B, the Muſcle named *Deltoides* D C, which only raiſes the Arm in this Poſition exerts a Force of above 60000 Pound? See the ſaid *Borelli*, *Par.* 124, at the End.

Thirdly, If any one hanging his Arm directly downwards, lifts a Weight of twenty Pound, with the third or laſt Joint of his Thumb, can he learn without Amazement, that the Muſcle which bends the Thumb, and bears that Weight, uſes a Force of about 3000 Pound? He that doubts of it, may conſult the abovementioned *Borelli*, *Par.* 86, 126.

But, *Fourthly*, He who ſees that the *Muſculi Glutæi* which together compoſe the greateſt Part of the Buttock, and move the ſame about the top of the Hip-bone backwards, do exert a Force of above 300000 Pound, when they raiſe a Weight of 65 Pounds, by extending horizontally the Bones of the Leg and Thigh, according to the Experiment of *Borelli*, *Par.* 125. I ſay once again, whoever ſees and underſtands this, muſt needs admire the Power of his Great Creator, that has endowed our Muſcles with ſo vaſt a Strength. See *Borelli*, *Par.* 125.

Eſpecially, if we here add, *Fifthly*, that calculating all the Forces of the Muſcles that are exerted when a Man, ſtanding upon his Feet, does only leap or ſpring upwards the Heigth of about two Foot; if the Weight of ſuch a Man be a hundred

and

and Fifty Pound, the Muſcles in that Action will exert above 2000 times more Force, that is to ſay, about 300000 Pounds. *Borelli, par.* 175. computes it yet higher.

And *Sixthly*, that the Heart at each Pulſe or Contraction by which it protrudes the Blood out of the Arteries into the Veins, exerts a Force of above 100000 Pounds; ſee the ſame *Borelli, Par.* 76. *p.* 11. we chuſe rather to ſpeak of theſe Matters in round Numbers, than exactly to follow his Calculations, (which are every where larger) that we may prevent any Cavilling in theſe ſurpriſing and wonderful Matters.

Sect. XV. *Convictions from the foregoing Obſervations.*

Yea, if the Force of the Muſcles were really much ſmaller, ought we not to ſtand amaz'd at it, whilſt we thus diſcover in our Bodies the Divine Power of our Creator, producing ſuch ſtrange Effects with a Matter ſo fine and tender as the Fleſh of an Animal, contriving and diſpoſing them in ſo narrow a Compaſs, and adapting 'em to ſuch regular Ends? When we ſee the Joints form'd, and their Motions maintain'd by perpetual Fountains of Oyl and Water (of which more hereafter) to preſerve them ſmooth and ſupple? And above all, when we ſee ſuch ſurprizing Force in many Muſcles ſo readily obeying his Will, that is to ſay, Moving and Reſting as we pleaſe; and others again, moving Spontaneouſly and Involuntarily; and farther, a Faculty or Power placed in the Muſcles themſelves, whereby, tho' their Motion ceaſes, they are contracted or ſhorten'd; and this Power balanced by a contrary or oppoſite one, in ſuch a manner, that the Parts of the Body may alſo keep their juſt Proportions, without any Concurrence on our ſide; as,

for

for instance, the Mouth is preserv'd and held exactly in the middle of the Face, by two Muscles drawing against, and balancing each other; this is very obvious, when one of those Muscles having lost its Force by any Disease, the other shall convulse or draw the Mouth awry, and thereby the Face will be depriv'd of its beautiful Regularity and Uniformity.

Sect. XVI. *Transition to the Demonstration of the Force of the Muscles.*

Whilst I am writing this, it is objected to me by a certain Learned Person, that what has been said about the Force of the Muscles, will not appear to all Readers so strange as really Incredible; since it will not easily be admitted by any Body without further Proof, that a Power of so many Thousand, yea Hundreds of Thousand Pounds, can be exerted by the Flesh of a Humane Body: Wherefore, that we many not give occasion to *Atheists* and *Scepticks* to think that we rather affect to say something here that is surprizing and uncommon, than what is true; it seem'd necessary to shew in some manner the Grounds of our Assertions: He own'd indeed, that I had referr'd those who doubted, to *Borelli* and his Learned Work, but that the same could not well be read and understood but by experienced Mathematicians; but forasmuch as all of them did not entirely agree in their Investigations of Nature, the unhappy Philosophers whom we endeavour to confute, might pretend from thence to avoid the Force of this plain Proof of a Great, Powerful, Wise and Gracious God.

For which reason, he added, if it could conveniently be brought about, it would be of great Use to demonstrate this Force of the Muscles, which so far surpasses all Belief, upon such Grounds as might easily

Fig. 4.

Fig. 3.

Fig. 2.

Fig. 1.

fronting Page 156

TAB. V

Fig. 1

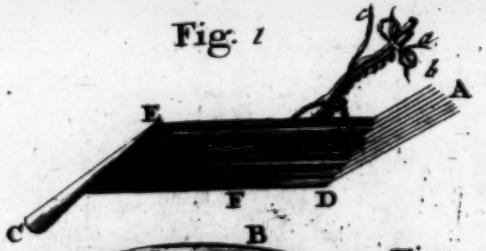


Fig. 2



Fig. 3



Fig. 7

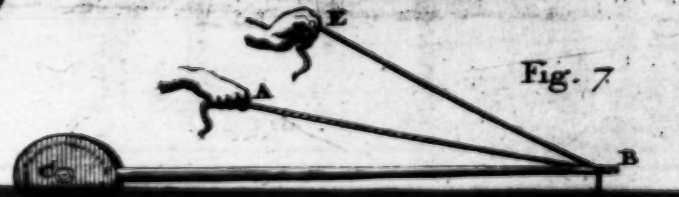


Fig. 8

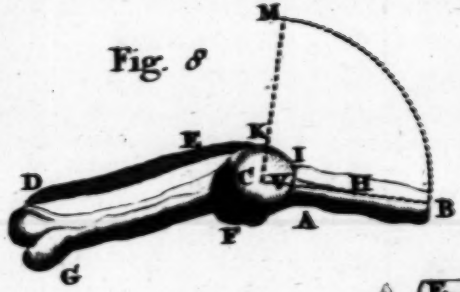


Fig. 5



Fig. 9

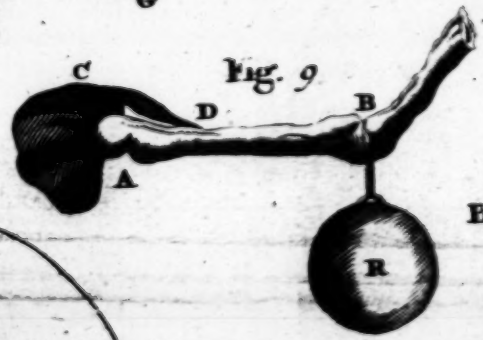


Fig. 6

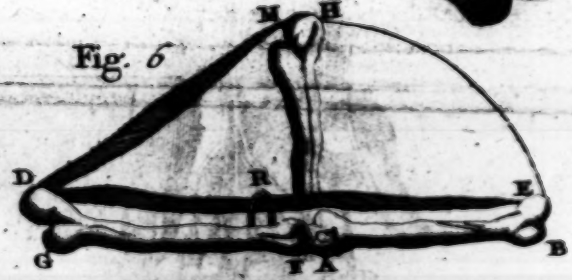








Fig. 4

Fig. 10



ſily be apprehended by a ſenſible Reader, tho' no well verſt in Mathematical Sciences.

This Conſideration has prevail'd on me to inſert here the following ſhort Digreſſion, which may help to give thoſe that are unexperienced, a clearer Conception of what *Borelli* has diſcover'd in this Matter, in which I have therefore repreſented the Greatneſs of the Force of the Muſcles as clear as I can, without adding thoſe Mathematical Demonſtrations, ſo tedious to ſome, and ſo unintelligible to others; requiring nothing more of our Reader, but that, beſides the knowledge of a few and common Mechanical Inſtruments, he underſtands never ſo little the Uſe of the Tables of *Sines*, and the Computation of plane Rectangular Triangles, which may be learn'd by any reaſonable Perſon, if he be rightly inſtructed, in a Week or leſs; in caſe he thinks this great and convincing Proof, of the Perfections of his Creator, deſerves ſuch Pains: However, if there be any who have no Inclination this way, they may paſs by theſe Demonſtrations, and proceed to the following Matters.

Sect. XVII.

Brief Demonſtration of the Force of the Muſcles.

1. NOW to repreſent to an ordinary Capacity, and convey, in ſome meaſure, to the meaneſt Underſtanding a clear and diſtinct Notion of the great Force of a Muſcle, as it were by Gradations: Let us ſuppoſe (*Tab.* VI. *Fig.* 5.) that the Muſcle, K D Q P, is the *Deltoides*; of which mention has been made above (§. 14.) whoſe Office is to lift up the Elbow.

2. This, according to *Borelli*, (§. 82.) is a Radi Muſcle, compoſed of ſeveral Plumiformar Muſcle like H Z Q L, and G V P W. See below 154

3. Let us here, for Plainneſs and Convenienc ſake, imagine this Muſcle to conſiſt only of the two Plumiformar Muſcles, *viz.* H Z Q L, an G V P W.

4. How this Force will be calculated, whe the Muſcle is compoſed of more Plumiforma Muſcles than two, will be made appear here after.

5. Theſe Muſcles are called Plumiformar; be cauſe that in G V P W, the moveable Tendo D G P has inſerted into it, on both Sides, great number of carnous Fibres, as G V P W all which, like the ſingle Feathers of a Quill, ru parallel to each other, and are faſten'd to the op poſite Tendon V P W, which being immoveable cannot follow.

6. Seeing, therefore, theſe carnous Fibres G V and G W, are both of them faſt and immove able at V W; and ſeeing, that each of them is t be contracted by a Power, be it what it will; th Conſequence muſt be, that of neceſſity they are t be drawn upwards, together, from G to N.

7. After the ſame manner, likewiſe, the Poin H is drawn up to O, in the other Plumiforma Muſcle, H Z Q L, by the contraction of all th lateral Fibres, as H Z and H L.

8. We ſee, that the Points H G, or rather th Tendons, D H and D G, being lifted up to O an N; the Point D, and therewith the Tendon K D muſt neceſſarily follow directly, and be drawn up in a Right Line, to X.

9. If the Forces, which draw the Points H an G upwards to Q and P, be equal, the Obli quities or Angles, H D X and G D X, muſt cer tainly be equal alſo; then taking this for granted, as

as we ſuppoſe it is; it follows, that there will be an Equality in the Muſcular Fibres, aforementioned, not only as to their Obliquities or Angles, N G M, N G R and O H L; O H Z, which theſe, and all the other Fibres form with their moveable Tendons, H Q and G P; but there will alſo be an Equality as to their Forces.

10. Theſe Angles, H D X and G D X; as alſo, V G N and W G N, and in the other Muſcle, Z H O and L H O (which form the Directions of the obliquely drawing Forces D G or D H, with the Direction of the perpendicularly drawing Force, D X; and of the Muſcular Fibres, G V, G W, or H Z, H L with their moveable Tendons) we ſhall hereafter, for Brevity ſake, call *Angles of Obliquity*.

11. To proceed; let B be the Elbow upon which the Weight T, hangs; let B I A be the upper Bone of the Arm or *Humerus*; let K E F A be the round Bone thereof, which can turn in the Cavity E F, in the Shoulder, about the Center C; and laſtly, let the Tendon D K I, which is inſerted in the Bone at I, touch the round Bone at K, at the Extremity of it.

12. Thus it muſt appear to every one, that when the Tendon D K I (8) is drawn up to X, according to the Line K X, the whole Bone I B A, will turn about the Center C; and K will be moved to *n*, and B to *m*; 'tis plain the Weight T, by the contracting Power of the two Plumiformar Muſcles, muſt thus be lifted up.

13. This therefore is a ſhort Deſcription of the Action of the Muſcle *Deltoides*, when it lifts up the Weight T hanging upon the Elbow B; or rather Poiſing it in Equilibrio.

14. To enquire further into the Force of this Muſcle, let us begin from the Weight T, and proceed upwards to the Muſcle.

15. This Weight T, according to the Obſervation of *Borelli*, (§. 84.) is found to be 55 Pounds; which (the weight of the Arm being included) is what being hung at the Elbow may tolerably be ſupported.

16. Since the Weight T draws the Bone of the Arm B A I downwards; and the Tendon I K D, draws the ſame upwards, by the Force of the Muſcle D Q P;

17. It is eaſy to perceive (and is what has been obſerved before) that theſe two Powers here do reſiſt each other, like the *Steelyard*, or Angular Balance, B C K.

18. We likewiſe ſee that the Arms of this Balance, B C and K C, are of very unequal Lengths.

19. Now every Body knows that a Weight, ſuch as *t* here, drawing with a Chord *t r* D K, the ſhorteſt *Brachium* or Arm, C K, muſt be much greater than the Weight T, which hangs at the longeſt Arm, C B, to cauſe them to balance one another.

And therefore we ſee, by theſe unequal *Brachia*, B C K, that the Force of the Muſcle D Q P, which draws the Arm K C, inſtead of the Weight *t*, muſt be greater than the Gravity of the Weight T, or 55 Pounds.

21. To proceed, then, to ſhew how much the Force of this Muſcle muſt be greater than the Weight T: It is a known Rule in *Mechanics*, that if the Weights T and *t*, are faſtened to a Balance of unequal Arms turning at C (which either hang ſtreight down, as in *Tab.* VI. *Fig.* 2; or makes an Angle at C, as in *Tab.* VI. *Fig.* 3.) each of them drawing at right Angles at K and B, the reſpective Arms of the Balance, the Weight *t*, hanging at the ſhorteſt Arm K C, muſt be, in order to make an Equilibrium, ſo many times greater than the Weight T at the longeſt Arm; as the long-

eſt

eſt Arm, B C, is longer than the ſhorteſt Arm, K C.

22. Every one that doubts of this, may from Experience be convinced, by making ſuch Balances or Steelyards, which may be effected, by bringing the Gravity of the Arm it ſelf, in ſuch a Poſition with the Weight, as Mathematically to obſerve an Equilibrium therein.

23. Now, granting the Rule (21) to be true, as it apparently proves to be; *Borelli* finds (§. 84.) by exact Scrutiny, that the Length of the Elbow B C, (*Tab.* VI. *Fig.* 1.) from B, where the Weight T is ſuſpended to C, the middle of the round Bone or Joint (which Length B C, makes the longeſt Arm of the Balance) is Fourteen times as long as K C, the half Thickneſs of the ſaid round Bone K E F A; the Semidiameter of which makes the ſhorteſt Arm of the Balance.

24. For which reaſon then, according to the foreſaid Rule (21) the Tendon K D, drawing from the ſhorteſt Arm K C, ought to have fourteen times the Force of the Weight T, in order to reduce the whole to an Equilibrium.

Now this Weight T, according to (15) the Obſervation of *Borelli*, is 55 Pounds: So then the Force, wherewith the Tendon K D muſt be drawn up by the Muſcle, or by the Weight *t*, in order to maintain the ſaid Equilibrium, is equal to 14 times 55, or to 770 Pounds.

25. And thus we ſee how much the Force, which the Muſcle D Q P exerts, muſt over-balance the Weight T, which it raiſes up only from the Head of the Steelyard B C K; becauſe it draws the ſhhrteſt Arm K C.

26. For inſtance; imagine the Tendon K D continued to *r*; and further, ſuppoſe the Weight *t*, hanging perpendicularly from the Pulley at *r*, and ſo faſten'd to the Tendon K D, that the Pulley

may play (or run round); 'tis manifeſt, that the Weight *t* muſt amount to 770 Pounds, if it Poiſes the Weight T, or makes an Equilibrium with it.

27. But now if this Force of 770 Pounds were to be produced by two other Forces operating obliquely, according to D G and D H (inſtead of the Weight *t*, whoſe Power is directed by the Strait-line K D *r*) we ſhoud perceive this Motion to be, according to what the two Plumiformar Muſcles, H Z Q L and G V P W, muſt neceſſarily be apprehended, by their moveable Tendons, D Q and D P, to produce.

28. It is then plain, that each of theſe two Plumiformar Muſcles, H Z Q L and G V P W, muſt raiſe the half of 770, or 385 Pounds; it being granted, that the Forces, as well as the *Angles of Obliquity* H D X and G D X (10) of each Plumiformar Muſcle, are equal to one another.

29. There does therefore occur in this Muſcular Structure another Machine, or rather a Pulley, whereby we may learn, that the Plumiformar Muſcles will each of them exert a greater Force than 385 Pounds, or 770 Pounds together; and this Augmentation of their Force is owing to the Alteration of the Line of Direction of the Power which here draws, by theſe two Muſcles, obliquely; deviating, at the ſame time, from the direct Line K D X *r*, and forming the Angles K D G and K D H.

30. To prove this, ſuppoſe (*Tab.* VI. *Fig.* 4.) a Weight K, of 770 Pounds, hanging at a Cord, K D *r*, which turning over a Pully *r*, has at its other End another equal Weight *t*, *viz.* of 770 Pounds, capable of ſupporting the firſt Weight K.

31. Now let it be imagined, that this Weight *t* is taken quite away; but to ſupply its place, two other Weights are ſubſtituted, *viz.* P and Q; the Chords of which Weights, *viz.* P *n* D and Q *b* D, run about the Pullies *n* and *b*; and both are faſten'd to

to the Rope X D at D; and form the Angles *a* D X and *b* D X.

32. It is plain, that if the Weights P and Q be equally heavy, and the *Angles of their Obliquity* (10) G D X and *b* D X, be equal, each of them muſt raiſe the half of the Weight K, which is computed to be 770 Pounds; that is to ſay, each muſt raiſe 385 Pounds.

33. This is what is obſerved before in the Caſe of the two Plumiformar Muſcles, Z Q L and V P W, (28) with no other Difference than here, inſtead of the two Plumiformar Muſcles, two Weights, P and Q, are ſubſtituted, to render the Demonſtration more intelligible.

34. But here occurs another notable and known Truth in Mechanics: If two equal Weights, P and Q, do hold in Equilibrium a third Weight K, with the Apparatus of Cords repreſented here, in *Tab.* VI. *Fig.* 4. and deſcribed (31) each of thoſe two Weights, P and Q, muſt be ſo many times heavier than the half of K (or 385 Pounds) as the Line D G is longer than D X.

35. Obſerving at the ſame time, that the *Ratio* (or apparent Length with reſpect to each other) of the Lines D G and D X, are found by taking *ad libitum*, a Point, as X, in the extended Line K D, and from thence drawing the pricked Line X G, ſo as to make the right Angle G X D.

36. To know then how many times the Weights P and Q are each of them greater than the half of K, or 385 Pounds, we need only enquire how many times D G is longer than D X.

37. And this is found by knowing the Chord of the *Angle of Obliquity*, G D X (or the Number of Degrees ſubtended by a Line falling at right Angles at X, and cutting part of the Arc of a Circle at the Points X or G, the Center of which Circle is to be at D): Therefore, having found the Angle

G D X, the Angle D G X is known of courſe; becauſe the whole Triangle being rectangular, the two Angles, G D X and D G X, muſt be equal to one Right Angle, or to the Angle D X G.

38. After which (35) drawing a Line at pleaſure *d x* (*Tab.* VI. *Fig.* 5.) and ſo as it may be divided into 385 Parts, by a pair of Compaſſes, and drawing from it at *x* another Line *x m*, which makes the Right Angle *d x m*, and drawing from *d* another Line, *d n*, which muſt cut *x m* at *g*, and form with *x d* the known Angle of Obliquity *x d g*.

39. Then if we meaſure the Line *d g* with the Compaſſes, and obſerve how many ſuch Parts (of which 385 make up the Line *d x*, in this inſtance) are contained in the ſaid Line *d g*, we ſhall find, in this caſe, the Parts of *d g* to amount to about 442,4. Whereby it will be known that *d x*, in *Fig.* 5. or D X, in *Fig.* 4. Is to *d g*, or D G:: As 385 : To 442.

And according to the Rule (34) that the Weight P or Q, will each of them amount to 442 Pounds, and conſequently ſo far exceed the half of K, being 385 Pounds: By this way, even thoſe who do not underſtand Mathematics, may be made to apprehend theſe Demonſtrations.

41. But they who have made the leaſt Progreſs in that Science, and are but tolerably verſed in the Calculations of Plane Trigonometry, may, without this round-about way of Admeaſurement, or making the new Right angled Triangle *d x g*, (*Tab.* VI. *Fig.* 5.) have recourſe to the Tables of *Sines*, *Secants* and *Tangents*, with the ſame eaſe as if the Line D X (*Fig* 4.) were really divided into 10.000,000 of Parts; or, if ſo much Exactneſs be not required, into any leſs Number.

42. For if you ſearch thoſe Tables for the Secant Line of ſuch a number of Degrees as the Oblique

lique Angle G D X contains, you have exactly the conſtituent Number of Parts of the Line D G.

43. And comparing theſe 10.000,000 Parts, with the Number found in the Secant correſponding, you will have the Proportion of D X to D G; or know how many times D G exceeds D X in number of Parts; and conſequently how much heavier the Weight P is than the half of the Weight K.

Therefore it appears,

44. That as the *Radius*, or 10.000,000 : To the Secant of the *Angle of Obliquity* G D X :: So is D X : To D G; or (36) the half of the Weight K, to the Weight P.

45. Now to bring this home to our Caſe, *Borelli* finds (§. 82.) that the Obliquities of the Tendons D G and H D (*Tab.* VI. *Fig.* 1.) upon the Tendon K D X, *viz.* the Angles X D G and X D H, are equal, each, to 30 Degrees; and the Secant of 30 Degrees, as appears by the ſaid Tables, is 11.547,005.

46. Now ſince an Inconveniency attends the Greatneſs of theſe Numbers; and ſince the Calculation here before us does not ſeem to require ſo great Exactneſs, the Proportions may be ſufficiently expreſſed, tho' as many Letters, or Cyphers be cut off from each of theſe Numbers (*viz.* 100.000,00 and 11.5470,05) as ſhall be thought convenient; that if from each five Figures or Cyphers be laid aſide, the remaining Proportion, 100 and 115, will expreſs this Matter clearly enough: Therefore, if D X were to be divided into 100 Parts, D G wou'd as much exceed D X as 115 exceeds 100.

47. Suppoſing the Caſe to ſtand thus: Theſe 100 Parts (or the Radius) according to (34): Are to 115, or the Secant of 30 Degrees (or D X to G D) :: As 385 Pounds, or the Half of the Perpendicular Weight K: To 442 Pounds, or the oblique ſuſpended Weight P (*Tab.* VI. *Fig.* 4.)

Which

Which is in brief thus; $DX : GD :: \frac{K}{2} : P$, o

the ſame in Numbers; 100 : 115 :: 385 : 442.

48. Now this Weight P, repreſents the Forc of the Plumiformar Muſcle, G V P W (*Tab.* V *Fig.* 1.) which therefore in this caſe muſt be 44 Pounds.

49. And thus we ſee how the Muſcular Force which was angmented before (24 and 25) by th ſhortneſs of the Arm of the Steelyard, is here ye more augmented by the Obliquity of this Draught tending towards D G; namely, from 385 to 44 Pounds.

50. So that in caſe the Tendon D P, wer lengthened to *s*, and moved about a Pulley there a Weight *q*, muſt be ſuſpended to it there; an likewiſe one of the ſame bigneſs muſt draw th Tendon D Q, to the end, that by making to gether 884 Pounds, they may raiſe directly, or per pendicularly, the Tendon D K, by their Obliqu Draught; whoſe Force, according to the Directio D X, is equal, only, to 770 Pounds.

52. But if, farther, we ſhou'd again remove th Weight *q*, as before, and raiſe the Tendon D G according to the Direction D P, with the ſam Force of 442 Pounds, by the help of the two ob liquely acting Powers, according to G V and G W

52. The ſame Machines or Pullies occur her as before (29, *&c.*) (*Tab.* VI. *Fig.* 4.) and the ſam Properties in all Points.

53. And it follows (32 and 33) that the Power S V and G W, acting accordingly (*Tab.* VI. *Fig.* 1. each will raiſe to the half of 442, or 221 Pounds.

54. As alſo, that the Force G W, in order t operate as aforeſaid, muſt be as many times great er than 221 Pounds, or the half of the Weight *q* as G W is longer than G S; ſuppoſing again (35 that G S W is a Right Angle. 55. Th

55. The Proportions of both which, G S and G W, are found, if the *Angle of Obliquity* S G W be, moreover, known; after the ſame manner as we have ſhewn above (from Propoſition 35 to 44.)

56. That is (by the Rule 44) As the Radius, or 100,000: Is to the Secant of the *Angle of Obliquity*, S G W (or by 34): : So is the Half of 242 or 221 Pounds: To the Force that muſt act according to G W.

57. Now, in order to diſcover the Power of this laſt Force, *Borelli* finds (§. 82,) that the *Angle of Obliquity*, S G W, made by the contracting of the carnous Fibres G W, with their moveable Tendon G P, is an Angle of 8 Degrees; the Secant of which (ſtriking off the two laſt Cyphers) appears by the Tables to be 100,982 : 58.

58. And conſequently according to 47.

As 100,000, or the Radius: To the Secant of 8 Degrees, or 100,982: : So is the Force of 221 Pounds drawing directly: To 223 Pounds; or the Force which draws obliquely, according to G W, when it raiſes the ſaid 221 Pounds perpendicularly, according to the Direction G S.

Which in ſhort ſtands thus;

100000 : 100982 : : 221 : 223.

59. So then the carnous Fibre G W, exerts a Force of 223 Pounds in this caſe when it operates ſingly; and when the Plumiformar Muſcle, G V P W, has no more than this only moveable Fibre, G W, on this ſide.

60. We will ſuppoſe it to be really ſo, in order to render it more intelligible to unexperienc'd Perſons; and afterwards briefly ſhew, how it wou'd be, in caſe there were in each half G P W, of the Plumiformar Muſcle, as many more Fibres as may be imagined.

61. In the mean while, ſince according to this Suppoſition there are two Plumiformar Muſcles, as G V

G V P W and H Z Q L, of which this great Muſcle or *Deltoides*, is compoſed; and ſince each Plumiformar Muſcle has two Sides, each of which (59) exerts a ſeparate Force of 223 Pounds, and joyntly a Force of 446 Pounds; this then is the Force of the whole Plumiformar Muſcle, G V P W.

62. Thus we ſee that this whole *Deltoides*, conſiſting of two Plumiformar Muſcles, or four half Sides thereof, by the Force of the Steelyard B C K (25) does balance, by the firſt oblique Draught of the Muſcular Fibres, G V, G W and H Z, H L, a Force, or Weight, four times 223 Pounds, or 892 Pounds.

So, that inſtead of the Force of each carnous Fibre, G W, *&c.* there hung, ſuſpended, a Weight *p*, of 223 Pounds to each; four ſuch Weights muſt operate with the ſame Force, as the four ſides of the two Plumiformar Muſcles; and thereby the Weight T, hanging to the Elbow B, wou'd be kept in Equilibrium.

63. Now to paſs on, further, to a greater Augmentation of the Force of the Muſcles, produced by the Structure of the carnous Fibres G V, G W, Z H, H L, *&c.* which are moveable; and alſo produced by the Texture of the Muſcles themſelves.

64. We find, after the niceſt Scrutiny, that theſe Muſcular Fibres W G (*Tab.* VI. *Fig.* 1.) have ſeveral little, hollow Interſtices; which, whilſt the Fibres are extended lengthwiſe, as A B C D E (*Tab.* VII. *Fig.* 1.) are included within Right Lines; but when the Power which extended theſe Fibres ceaſes, theſe Interſtices appear in Circular Figures, as *w g*, *&c.* (or G M W, *Tab.* VI. *Fig.* 1.)

65. If now, by the Fibre W G, being immoveable at G, a Weight T, ſuſpended to it, muſt be raiſed; 'tis plain, that in performing ſuch an Action, by any Force (whatever it be) the Breadth or Thickneſs of the ſaid Fibre muſt be imagined to be encreaſed;

creaſed; and the Length, at the ſame time, muſt neceſſarily be diminiſhed.

So that the Parts A B C D E (*Fig.* 1. of *Tab.* VII.) being dilated, or made wider, do aſſume the Figures *a b c d e*; by which the Length of the Fibres W G, becomes viſibly ſhortened; *viz.* from W G to *w g*; and the Weight T, at the ſame time, is raiſed up to *t*.

66. This Tumefaction, or Swelling of the Fibres, which compoſe the Body of the Muſcle, does palpably appear in ſeveral Parts of our Bodies; and in ſeveral particular Muſcles, which contract themſelves in the Exerciſe of their proper Functions.

Let any Man, with either Hand, take hold of his other Arm juſt below the Elbow, to convince himſelf, whether or no he does not feel the Muſcles of the Arm ſwelling and contracting themſelves, when he opens and ſhuts the Fingers of the Hand which he ſqueezes that way below the Elbow.

67. Now whether the Figure of theſe long Particles, or little Tubes A B C D E (*Tab.* VII. *Fig.* 1.) be round, as a b c d e; or whether they may be imagined Square, as *a b c d e*, the better to determine their Co-operation with other Fibres, we ſhall not pretend here to decide; it being a Matter foreign to our preſent Purpoſe.

68. Neither do we here enquire after what manner, or by what Cauſes the Interſtices A B C, *&c.* become thicker, or how they aſſume the Form of *a b c*, *&c.*; concerning which, we leave every Man to enjoy his own Opinion, till the true and certain manner thereof be clearly and inconteſtably demonſtrated.

69. This is certain, that each carnous Fibre, as W G, conſiſts of a multitude of little Inſtruments, as A B C D E, each of which do become thicker and ſhorter in Motion.

70. The Truth of the laſt appears experimentally from above (*66*); it remains therefore to ſhew theſe

theſe little Inſtruments, *a*, *b*, *c*, *d*, *e*, *f*, &c. (*Tab.* VI *Fig.* 2.) in each Thread, *a p*, where a Contractio happens (and conſequently the Breadth muſt b augmented) are very many in Number, and the Mi nuteneſs of each exceeding fine.

71. Let us ſuppoſe, in *Tab.* VII. *Fig.* 3. *a* to be a Fibre with Interſtices; which, in it utmoſt Extenſion, reaches to *e*, or is of the Lengt *a e*; at the Tendon whereof a Weight *q*, being ſu pended, it is held in an Equilibrium; but as ſoo as *a e* is contracted to *a d*, the Weight *q* is raiſe to P.

72. Imagining this Fibre *a e*, to conſiſt but of on Machine, *viz. a b c d*, it wou'd be able to raiſ the Weight *q* up to P; becauſe the Line *a e* wou' even by this means be contracted to *a d*.

73. But that this will not anſwer the Motion o Muſcular Fibres, which we are here accountin for, appears;

Firſt, Becauſe when the Machine *a e* is ſo long the Thickneſs *b c*, would be incomparably greate than we now perceive in contracted Muſcles.

74. For if a double Fibre *a e*, were two Inche long, which, by contraction or ſwelling, muſ be blown up into the Circular Figure *a b c d*, th ſaid Circle would be 4 Inches, and its Diameter *b c* above one Inch and a Quarter; as is plain to thoſe who know that the Circumference of a Circle I to the Diameter, As 22 to 7, or thereabouts.

75. We have choſen here to repreſent an extended Fibre rather by a long Line, and a contracted on by a Circle, than by a Tube and a Globe, to which their Reſemblance bears greater Affinity; becauſe we wou'd render the matter as intelligible as may be to all Capacities.

76. *Secondly*, If the whole Fibre conſiſted of one Machine only, as *a b c d*, and one ſhou'd cut it acroſs at *b c*, the whole Fibre would at once be diſabled

diſabled from contracting, or exerting its drawing Power, ſo that it could never draw itſelf back to *a*; but more eſpecially, if the Contraction be performed by filling the Machine, or by the Expanſion of any Matter included therein; but in a Muſcle cut acroſs, Experience proves a Motion or Contraction, even after its Fibres are cut aſunder.

77. If now the Fibre conſiſted of two Machines, *a k g m* and *g h d i*, and which ſhou'd be divided from one another at *b c* through *g*, the firſt Machine muſt be contracted to *a*, and the ſecond to *d*.

78. But if this ſhould happen at *k m*, the Part *a k m* being cut through, would not be able to contract it ſelf to *a*; not to mention the too great Thickneſs of *k m* (as was obſerv'd before concerning *b c*) for this would be equally contradictory to Experience as the former.

79. Hence we are taught, that (*Tab.* VII. *Fig.* 2.) when the Fibre is cut through at *b* or *g*, or *k* or *l*, or wherever it be, each Part is drawn back to its Tendon to which it is faſtened, that is, to *a* and *p*; for Inſtance, if the Fibre be cut at *g*, the Machines between *a* and *f* are drawn to *a*; and thoſe between *g* and *l* to *p*; and thus we ſee, that by this means the Cut made through any Muſcle is viſibly larger than the Knife which made it.

80. From whence we may conclude, that on both ſides of the Cut, whether at *g b* or elſewhere, there muſt remain ſome Machines unwounded, which have in them a contracting Power, notwithſtanding the Separation; and by this means the Fibre is drawn inward, or contracted, after it is cut through in any Part.

81. For if either ſide ſhould be left deſtitute of theſe Machines, ſo that none were to be entire or uncut, the Conſequence muſt be, that that ſide ſo deprived of theſe Machines, could not be in a Condition to contain the Matter which is the Cauſe of

of the Fibre's ſwelling; and conſequently the F bre could not be actuated by any Power whi would draw it towards its Tendon.

82. But ſeeing it is ſcarce poſſible to cut a Fib through ſo near *a* or *p* (*viz.* at *m* or *n*) but th the Parts, as we find by Experience, do ſhrink both ſides, as well the ſhort ſide as the long, their reſpective Places.

83. It follows then, that how little a Part ſ ever, ſuch as *a* or I, be cut off from the Fibre one ſide, ſeeing it ſhrinks back, it muſt neceſſaril contain ſome Machines, at leaſt one entire one, it ſelf.

84. And conſequently from hence we may plain ly conclude, that the Machines, whereof the F bres are compoſed, muſt always be, each of the in particular, ſmaller than the Part cut off; an therefore of a wonderful Smallneſs.

85. From whence then it follows, that the Num ber, at the ſame time, of theſe Machines, if th Fibre be of any conſiderable Length, muſt be ver great.

86. *Borelli* (from whom the Reader may receiv ſufficient Satisfaction, concerning the Multitude an Minuteneſs of theſe admirable Mechaniſms, §.115. maintains, that ſince every Fibre is ſmaller than Woman's Hair; each Cavity A B C D E (*Tab.* VI *Fig.* 1.) which being contracted, forms a Machin *a b c d e*, muſt therefore be finer than the ſai Hair.

87. Now if theſe Machines be as broad as long each Fibre will contain as many of them length wiſe, as there can lie Hairs breadth-wiſe on the ſai Length of this Fibre.

88. But according to the Calculation of the ſai *Borelli* (§. *ibid.*) Fifty Fibres, placed breadth-wiſe b one another, do not amount to the ſpace of on Inch.

89. Where

89. Wherefore, according to this Computatio n ſity of theſe Machines muſt go to conſtitute a Portion of a Fibre of one Inch in Length.

90. But for Caution ſake, and to keep within Compaſs, that Author does not calculate above twenty Machines for every Inch of Fibre.

91. Which Calculation we may ſafely allow him; becauſe, if any one may think it more convenient to imagine theſe Machines not to be altogether as broad as long, here is room enough to humour any ſuch Conjecture: For by this means, theſe Machines will have their Length exceeding their Breadth by ½, *i.e.* they will be more than three times as long as broad.

92. To return then to the Force of the Muſcles; there appears here, in each Fibre, a new Inſtrument of the following Structure; *viz.*

Firſt, We ſee, in *Tab.* VII. *Fig.* 1. a great Machine W G, conſiſting of ſeveral ſmaller ones, as A B C D E, *&c.*

Secondly, That they are ſo formed, that each little Machine, A or B, being contracted by a particular Force, into Circles or Squares, or other Figures, *i.e.* expanded, as at A or B, *&c.* or otherwiſe (in another Form) at *a* or *b*, *&c.* contributes its ſhare towards raiſing the Weight T.

Thirdly, That being joyned, or linked, to one another at *a*, *b*, *c*, *&c.* they do likewiſe aſſiſt each other in raiſing the ſaid Weight.

Fourthly, When this Machine, *w g*, conſiſts of more or fewer little Machines, as *a*, *b*, *c*, *&c.* which operate here at the ſame time, the Weight T muſt accordingly be raiſed to a greater or leſſer Heighth (as the Number of Machines are multiplied or diminiſhed) and conſequently the ſame Weight T, will be moved with greater or leſs Velocity: For inſtance; if there be ten times as many little Machines, contracting themſelves, the Weight T

will be raiſed ten times higher; and at the ſam
time, it will acquire ten times more Velocity.

93. All theſe Properties being ſo uſeful and n
ceſſary for a right Conception of the Motions
the Muſcles; and being a neceſſary Conſequen
reſulting from their Structure; we ſhall endeavo
to demonſtrate them by a Machine (adapted b
Mechaniſts to other ſort of Uſes) which ſeems
have a pretty near Reſemblance to the Natu
and Office of the Muſcles in general, and
give the beſt Light into this Matter.

94. Let us then ſuppoſe a Machine (*Tab.* VI
Fig. 4.) in which a Weight T, hangs at a Cor
which being wound about the Pullies 1 *a*, 2 *a*, &
and 1 *b*, 2 *b*, *&c.* in the manner deſcribed by th
ſaid Figure, is terminated and faſtned to th
Nail *d*.

Then to each Pulley, at 1 *b*, 2 *b*, 3 *b*, 4 *b*, l
there be ſuſpended an equal Weight, *g h m*
which four equal Weights, preſſing altogethe
downwards, the Weight T will be thereby raiſe
up and kept in Equilibrio.

95. Now we may ſee in this Machine of Pu
lies, all the ſame Phænomena which have been m
nifeſted in the Muſcular Fibres (92); namel
that the whole Structure conſiſting of many litt
Machines, each does, by a proper Force, bear
reſpective Part in raiſing the Weight *t*; which a
together united, accumulate their Powers ſo as t
prove mutually aſſiſting the one to the other.

96. For if the Cord be carried only from
through 1 *a*, 1 *b*, and terminating at *e*, be the
faſt'ned to a Nail; we have a Machine, whic
acting by the ſole Power of *g*, raiſes *t*. And
caſe the Cord be continued from the Nail *e*, o
to the Pullies, 2 *a* and 2 *b*, and be faſt'ned to a
other Nail at *f*; this will be a ſecond Machin
actin

acting by the Power *b*; which, if it be joyned to the firſt, will help to raiſe the Weight *t*.

97. If theſe Machines and Weights be multiplied, by continuing the ſaid Cord farther on thro' 3 *a* and 3 *b* to *i*, and from thence thro' 4 *a* and 4 *b* to *d*, and ſo on; and a diſtinct Weight ſuſpended to each, as *m* and *n*.

We ſhall have a great Machine produced, from all theſe little ones; in which the three firſt things expreſſed in *Prop.* 92. and repeated in *Prop.* 95. will occur.

98. We ſee likewiſe, that the fourth thing deſcribed (*Prop.* 92.) which ſeems to be of the greateſt Importance in this Muſcular Demonſtration, does here meet with an exact Reſemblance; *viz.* by how much the number of little Machines is multiplied, by ſo much the more ſwiftly will the Weight *t* be raiſed up.

99. This is eaſy to be apprehended by Conſideration, without the Circumſtances of Demonſtration; for if *g* only acts on the firſt Machine, which is ſuppoſed to end at *e* (96) and the Center of the Pulley, 1 *b*, being firſt at *r*, is drawn down to 1 *b*, ſo that it has twice 1 *b r* added to its length, in a determinate ſpace of Time; ſuppoſe in one Pulſe or Second of a Minute, the Weight *t* will be raiſed to T, in the ſame ſpace of Time the heighth of T, which is equal to twice 1 *b r*.

Becauſe the Pulley 1 *b* being thus run down from *r* to 1 *b*, the whole Cord, 1 *a*, 1 *b*, *e*, paſſes thro' the Pulley 1 *a*; which Cord retains, as we ſee, on each of the two ſides, *viz.* on the ſide 1 *a* 1 *b*, and on the ſide 1 *b e*, the length of 1 *b r*; and conſequently is twice the length of 1 *b r*.

Now in proportion to the quantity of Cord, running thro' the Pulley 1 *a*, the Weight *t* muſt be raiſed from *t* to T; which muſt neceſſarily be twice the length of 1 *b r*.

100. If now we joyn the Second Machine, the Cord of which ends at the Nail *f*, with its particular Weight *h*, it may be eaſily (96) inferred, that when both the Powers *g* and *h* concur in their Operation, to draw down the two Pullies 1 *b* and 2 *b* from *r* and *r*, which are above (the length of 1 *b* *r* or 2 *b* *r*, which are equal) in ſuch caſe, I ſay, it may be inferr'd, that four times the Length of 1 *b* *r* paſſes thro' the Pulley 1 *a*, exactly in the ſame ſpace of Time; as may be ſeen by the four Cords A B C D; and conſequently, that the Weight *t* will be raiſed to T, the heighth of 1 *b* *r*, multiplied by four, in the ſaid ſpace of time.

101. If therefore theſe Machines and Powers *m*, *n*, *&c.* were to be further multiplied, and all the Weights drawn down together in one Second of Time, it is plain that the Weight *t*, according to the number of Machines, muſt always, in the ſame ſpace of time, be raiſed higher; and conſequently move with greater Velocity.

And thus what is ſaid (92) concerning the Force of the Muſcular Fibres, is demonſtrated in this Machine.

102. Now, ſince this Machine of Pullies operates after this manner; thoſe who are verſed in *Mechanics* know that it is endow'd with the following Properties.

Firſt, That altho' we take a greater number of the ſeveral little Machines, and the Weight *g*, *h*, *m*, *n*, that draw them, yet they, joyned all of them together will not be able to raiſe or poiſe in Equilibrio a greater Weight than *t* or T; which *g* only operating by it ſelf, cou'd poiſe the ſame way.

Secondly, But the Velocity, wherewith the Weight *t* riſes to T, will, by the Multiplication of theſe Pullies, be proportionably augmented; *viz.* by how much the number of theſe Pullies are encreaſed

creaſed, by ſo much ſwifter will the Weight *t* riſe up to T.

103. To prove this, let us ſuppoſe the Pullies, 4*b*, 3*b*, 2*b*, 1*b*, (*Tab.* VII. *Fig.* 5.) to be each of them brought inwards to *r*, *r*, *r*, *r*, by the gravitation of the Weights T T falling down to *t t*; ſo that the Pullies on each ſide, to wit, 1*a*, 2*a*, 3*a*, 4*a*, may be in the common ſtreight Line *d* Q, indiſcriminately equal with the others, 1*b*, 2*b*, 3*b*, 4*b*; the ſtreight Line, *r*, *r*, *r*, *r*, paſſing directly thro' the Centre 1*a*, from thence thro' 1*b*, at the Center, and ſo on; in this State the Muſcular Fibre *d* Q is to be apprehended to be extended to its full Length, and conſequently inactive; and each little Space, *d d* R R, R R S S, S S B B, and B B Q Q, will perfectly repreſent the little Machines of a Fibre which is in the State of Reſt.

But if now the ſide *d* R be extended both ways, to *d* D R, the Space *d* D R R D *d* will in ſome meaſure, give us a Repreſentation of one of the Machines of a Muſcular Fibre inflated, or ſwelled up, in performance of its Function; becauſe the Cord by which the Weight T T is ſuſpended, is raiſed ſo high by the ſaid expanſion or ſwelling, and ſhortned at the ſame time ſo much below: By this means we receive a groſs Conception of the Action of the Fibres.

104. Since therefore the Properties enumerated (102) are very fitly applicable to this Machine of Pullies, as well as to every Fibre, which it is purpoſely adapted to repreſent; it occurs that the *Sixth* Obſervation ſhou'd here meet with an Application.

105. Namely, that in order to compute the Force of a Carnous Fibre, we muſt, according to what has been lately proved, multiply the Force of a ſingle Machine of any Fibre, by the number of all the little Machines of the ſame Fibre.

106. Now

106. Now *Borelli* computes, (§. 124.) that each of the Carnous Fibres of the *Deltoides*, *viz.* G W (*Tab.* VI. *Fig.* 1.) is two Inches in length.

107. And, according to *Prop.* 90, each Inch contains the Number of 20 little Machines; five only (for Example ſake) are marked here on the Fibre G W; conſequently the whole Muſcular Fibre G W, being two Inches long, contains 40 of theſe little Circles, or rather little Globes.

108. Each of theſe little Globular Machines, G M (59) can exert a Force of 223 Pounds, towards raiſing T, or a Weight of 55 Pounds, which hangs at the Elbow; becauſe (by *Prop.* 102, and 104.) one ſole Machine, G M, can act as much as 40 in making an *Equilibrium*.

109. So that by multiplying the Force of 223 Pounds (which one ſole Machine G M exerts) by 40, or the Number of ſmall Machines in a ſingle Fibre of the *Deltoides*, we diſcover the Force of the whole Muſcular Fibre G W; *i. e.* 40 times 223, or 8920 Pounds.

110. Now ſince this *Deltoides* is ſuppos'd to conſiſt of two Plumiformar Muſcles, each containing two diſtinct Sides, or Ranges, of Fibres, as G V P and G P W, in the Muſcle G V P W, as alſo H Q Z and H Q L in the other Plumiformar Muſcle H Z Q L, in all four Sides (each Side here being repreſented by a * ſingle Fibre G W) we muſt multiply (109) this Sum 8920 by 4, in order to find the Force of the whole *Deltoides*, which will then produce a Force equal to 35680 Pounds.

111. Now tho' this proves ſuch a Force in this Muſcle, as perhaps might ſeem incredible to a Perſon not conceiving the Demonſtration; and tho'

* *Vid.* Prop. 102. where one Machine keeps the Weight T in *Equilibrium*, and 100 Machines can do no more.

tho' this Force itſelf be more than ſufficient for our Purpoſe, yet we ſhall however ſubjoin the Demonſtration by which *Borelli* makes appear a Neceſſity of even doubling this Force.

112. *Viz.* It is obvious to Perſons skill'd in Mechanics, that a Cord K T (the Weight K (*Tab.* VI. *Fig.* 6) being ſuſpended to one end of the Cord, the other end being at the ſame time faſt'ned to a Nail T, which renders it there immoveable) ſuſtains as great a Weight, or Force, by the Suſpenſion of the Weight K alone, as if it bore double the Weight of K.

113. This is manifeſt; becauſe the Nail T contributes as much to the ſtraining of the Cord K T, as if the ſaid Cord K T, had another Weight, *m*, equal to K in gravity, hanging at the other end, which is ſuppoſed to be carried round the Pulley *r*; for this laſt Weight K may be perceived to be as well Balanced, or kept in Equilibrio, by the Nail T, as by the other Weight *m*, equal to it ſelf.

114. They who deſire to ſee this Matter demonſtrated more at large, may conſult the aforenamed *Borelli*'s Ingenious Treatiſe, *De motu Animalium*, in the 10*th Chap.* of the Firſt Part; it will anſwer our preſent purpoſe, if theſe Matters be made merely intelligible, for the uſe of ſuch as are not thoroughly verſed in Mathematics.

115. Now to apply this to the Muſcles (*Tab.* VI. *Fig.* 1.) it is plain from what has been ſaid, that the Muſcles there deſcribed, do repreſent a ſort of a Machine of Pullies; one end of the Fibres G V, G W, Z H, H L being faſt'ned to the Tendons, V P W and Z Q L, which adhere as immoveably to the Bones, as the Cords in the Machine of Pullies do to the Nails *d d*; whilſt the other, and moveable Ends of theſe Fibers G V, G W, Z H, H L, do each of them exert a Force (62) equal

to 223 Pounds; or the Power of each of theſe moveable Ends is equal to the Weight *q*, which is ſuppoſed to weigh 223 Pounds: But all theſe four Fibres operating together, will Balance a Weight of 892 Pounds.

116. If, according to *Prop.* 112. this Force be doubled, the Force which this *Deltoides* exerts, by the Poſition of each of its Fibres, amounts to 446 Pounds; and the Forces of all four acting together, to 1784 Pounds, beſides the Multiplication of this number by 40, which we are going to ſpeak of, and concerning which mention has been made already, *Prop.* 63.

117. And ſince we have hitherto ſuppoſed, that each Fibre, in theſe Demonſtrations, is endowed with one or more Machines, like GM; and foraſmuch as, according to *Prop.* 102, and 104. one ſuch Machine, as GM, can balance as great a Weight as all the 40 Machines of the whole Fibre GW; it will appear, ſince the Force exerted by each Machine is equal, that in order to Calculate, or make an Eſtimation of the entire Force of the whole *Deltoides* (or of the four Muſcular Fibres conſtituting it) we muſt multiply this Number 1784 by 40, or the number of Machines in each Fibre, which amounting to the Sum of 71360 Pounds, is the Force which (according to *Prop.* 102, and 104.) the *Deltoides* is capable of exerting.

118. Here this (*Tab.* VI. *Fig.* 1.) may likewiſe ſerve, in ſome meaſure, to demonſtrate from the foregoing Principles, the Force of the Muſcles called *Glutæi*, when they exert their Power, in raiſing Weights ſuſpended to the Heels.

119. The *Glutæus Major*, which is the Muſcle we are to ſpeak of, is, according to *Borelli*, (§. 83.) made up like the *Deltoides* of Plumiformar Parts.

120. Sup-

120. Suppoſe then B to be the Heel; *d* the Knee; KEFA the round Bone in the upper Part of the Thigh; the Weight, to be raiſed by the Heel B, muſt, according to *Borelli*, (§. 85.) be computed to weigh 65 Pounds.

121. We perceive here, that the Shin and Thigh-Bone together (which are repreſented by BC) comprehend, in length 31 Semidiameters of K C, or the round Bone of the Thigh.

122. If therefore an Equilibrium be to be made betwixt the Tendon DKI and the Weight T; the ſaid Tendon cannot be raiſed to X, by a Force leſs than 31 times 65, or 2015 Pounds.

123. And if this Force is to be exerted by two other Tendons DH and DG; each of them will not only bear the half of 2015 Pounds; but becauſe they draw in an oblique Direction, will ſo much exceed the half, or $1007\frac{1}{2}$, as DG exceeds DX in length.

124. But *Borelli* ſays, in relation to that (§. 83.) that the *Angles of Obliquity* XDG and XDH are each of 45 Degrees.

125. Conſequently (by the Tables of *Sines*, and caſting away the five laſt Cyphers) As the Radius, 100: To the Secant of 45 Degrees, 141 :: So $1007\frac{1}{2}$: To 1420 Pounds.

126. So that each of the Tendons, DG and DH, being drawn obliquely, muſt be acted on as if a Weight of 1420 Pounds, like DP or DQ, were ſuſpended over the Pulley P; otherwiſe their Force will not be equal to the Weight or Power which draws KD, according to the Direction KX.

127. And again; at DG, there are two other oblique Fibres, GW and GV: Theſe, to operate in like manner with the former, will each of them contribute a Force ſufficient to raiſe the half

of

of 1420, *viz.* 710 Pounds, gravitating perpendicularly in the Direction G P.

128. But becauſe they draw obliquely the Force which draws according to G W, will ſo many times exceed 710 Pounds, as G W exceeds G S in length.

129. According to (§. 83.) of *Borelli*, the Obliquity of this Angle is 8 Degrees.

130. Therefore by *Prop.* 58.

As the Radius 100000 : To the Secant of 8 Degrees, 100952 :: So 710 : To $716\frac{9}{10}$ Pounds.

131. Therefore each Fibre G W, repreſenting here one entire ſide, G P W, of this Plumiformar Muſcle, muſt in the caſe before us raiſe a Weight of $716\frac{9}{10}$ Pounds.

132. But further, according to *Borelli*'s Computation (§. 125) each of theſe Fibres is of the length of three Inches; conſequently each contains in its Compoſition 60 Machines.

133. Therefore let $716\frac{9}{10}$ (the Force found according to *Prop.* 130.) be multiplied by 60.

134. The Product of $716\frac{9}{10}$ multiplied by 60, or 43014 Pounds, equal to the Force which this one Muſcular Fibre G W (or even the whole ſide of one Plumiformar Muſcle, to which this Fibre is ſuppoſed to be equal) exerts towards raiſing up the Weight.

135. Now it being taken for granted, that the Muſcle D Q P, conſiſts of two of theſe Plmiformar Muſcles G W P V, and H L Q Z, containing betwixt them, four ſides: Therefore theſe two Muſcles exerting a joynt Force, will (by means of their four Sides, or four ſuch Fibres as G W) exert a Force equal to four times 43014, or 17205[illegible] Pounds.

136. But ſeeing that this Muſcle does adhere at one end to a Bone, as if it were a Nail T, (*Tab.* VI *Fig.* 6.) by its immoveable Tendon; and is only move[illegible]

moveable, ſo as to carry a Weight, like K, at its other end; this Force is therefore yet to be doubled; becauſe the Muſcle, by its being faſt'ned at one end, ſuffers as great a Strain, as if it had an equal Weight ſuſpended over a Pulley, at the other end.

137. Wherefore doubling 172056 (the great Force of this Muſcle) we find that 344112 Pounds does correſpond to the Power that the *Muſculus Glutæus Major* can exert in performing its Function.

138. And this is what we take to be ſufficient to inſinuate a general Idea of theſe Matters: If any one deſires to ſee a more accurate and exact Account, he may meet with more ample Satisfaction in the ſaid Book of Monſieur *Borelli*. We have been more brief in this Inſtance of the *Glutæus*, becauſe we judged it a needleſs Trouble to repeat Verbatim what has been demonſtrated more fully before in the Caſe of the *Deltoides*.

139. We might here conclude this Work, of Demonſtrating the Force of the Muſcles, if ſome Objections did not intervene, which might hinder Perſons not thoroughly skill'd in Mechanics (for whoſe ſake we condeſcend to this prolix way of Demonſtration) from acquieſcing in the Proofs that have been deduced from Mechanical and Mathematical Obſervations: Theſe Objections therefore we ſhall endeavour to obviate by ſuitable Remarks or Obſervations.

140. The firſt Difficulty that may perhaps be ſtarted, is that in *Tab.* VI. *Fig.* 1. we have repreſented one ſingle Muſcular Fibre in the room of an innumerable number of others, which conſtitute the whole ſide of the Plumiformar Muſcle G W P: Moreover, it ſeems agreeable to Obſervation, that one of theſe Plumiformar Muſcles, repreſented by G V P W, is not confined to two Plane ſides,

G W P

G W P and G V P; but diffuſes its Carnous Fibres, Pyramid-wiſe, in great multitudes from a Point, as G, like a *Verticillum* or Wheel, in the ſhape of the Extremity of the inverted Pyramid, V G W: This happening from all the Points, G N, *&c.* of the middle Tendon G D, theſe Fibres do in no faſhion repreſent a Plane; but conſtitute the Figure of a perfect Body, with Length, Breadth and Thickneſs.

141. In anſwer to this; to ſhew that our ſuppoſing theſe Muſcles to conſiſt of Plane ſides (which is a method we have judg'd moſt expedient to convey theſe Demonſtrations to the Underſtanding) does not in the leaſt alter or enervate the Force of the Demonſtrations; and to prove that the ſame prodigious Force wou'd manifeſt itſelf from every particular Muſcular Fibre, tho' the Calculation had been made from a greater number of the Fibres of a verticillated Body, inſtead of the two Fibres G W and G V.

Let ſuch as read this conſider, *Firſt*, that as we have only taken two Fibres, G W and G V, for the two ſides of the Muſcle, *viz.* G P W and and G P V (whether ſolid or plane) ſo likewiſe we have only aſcrib'd half of the Force of the whole Muſcle, G V P W, to each of theſe two Fibres, as by (61) where the Force of one carnous Fibre, acting according to *Propoſition* 59. was found to be equal to a Weight of 223 Pounds; to repreſent the Force of the whole Muſcle G V P W, we were under an Obligation of doubling 223 Pounds; ſo that the full Force of a Muſcle is repreſented by the Force of two Fibres, or 446 Pounds; this is the Foundation of what is to follow.

142. Now, for the benefit of unexperienced Perſons, we thus compute, that the Force of a Muſcle is the ſame, whether this Force be imagined to be center'd in two Fibres, as G W or G P;

GP; or whether the Force be diſtributed amongſt an infinite number of Fibres, contained in the ſpace GVWP; which ſpace you may imagine, if you pleaſe, to be occupied by a Body conſiſting of Length, Breadth and Thickneſs, and not a mere Plane Figure.

To this end, ſuppoſe (*Tab.* VII. *Fig.* 6.) a Weight D (not unlike *Tab.* VI. *Fig.* 4. and *Prop.* 48.) of 442 Pounds, ſuſpended at a Cord DOS, and ſupported by another equal Weight *q*. Now if we take away this Weight *q*, and balance the Weight D by a number of other Weights faſt'ned to oblique Cords, G, A, P, *&c.* each of which bears a Weight *m*, *h*, *g*, *p*, *n*, *&c.* on this Account.

If we now conceive the Cords to be ſo order'd, that there may be imagined 100 Points, like GAP, *&c.* in the length of the Cord GO, to which the oblique Cords, GW, GQ, AB, AE, *&c.* are faſt'ned: And moreover, that there are about each Point, as G, or A, or P, *&c.* not only two Cords, as here at G and A, but imagine to to be placed round the Circle, like the Spokes of a Wheel, or *Verticilla* of a Plant; four ſuch Cords we have deſcribed to iſſue from the Point P, *viz.* PV, PT, PH, PR.

Laſtly, let it be alſo ſuppoſed, that the Weights *g*, *h*, *m*, *n*, *p*, are equal to one another; and that the oblique Angles, MGN, BAP, RPO, *&c.* which each oblique Cord makes with GO, are alſo equal, and of 8 Degrees each.

It is therefore demanded, what the Weights *g*, *h*, *m*, *&c.* drawing obliquely, amount to? And how great a Force they muſt altogether, in Conjunction, exert, in order to Balance the aforementioned Weight D.

143. To find this, it muſt be conſidered, that we have imagined the Weight D to be drawn by a thouſand Weights, equal in gravity to one another

other: Since (according to *Prop.* 142.) there are ſuppoſed to be 10 obliquely drawing Weights, and alſo we have imagined 100 ſuch Points as P.

144. Wherefore each little Weight *g*, *h*, *m*, &c. muſt raiſe one thouſandth Part of the Weight D; or according to (142) a Gravity of $\frac{442}{1000}$ Pounds, which each was able to ſuſtain in the direct or perpendicular Line G O.

145. But conſidering that they draw obliquely, each ſuch Weight as *m*, muſt exert a Power ſo many times greater than $\frac{1}{1000}$ of D, or than $\frac{441}{1000}$, as the Line M G is longer than N G.

146. Now foraſmuch as the oblique Angle N G M, of each is, according to *Borelli* (57) of 8 Degrees; therefore by (58) if G N be 100000, G M muſt be 100982: It follows (if they operate proportionably) as G N: To G M:: So $\frac{441}{1000}$: To $\frac{445}{1000}$.

147. So that each little Weight, as *m*, muſt have the Gravity of $\frac{445}{1000}$, which is the firſt *Poſtulatum* (142.)

148. Now the Method, by which the Power of all theſe little Weights, when they exert themſelves in order to raiſe D, or 442 Pounds, is to be diſcover'd, ſeems to be the plaineſt thing in the World: For do but multiply the Force which one of them, as *m* for inſtance, exerts, *viz.* $\frac{445}{1000}$, by the number of all the little Weights, that is by 1000, and the Product is the Force of them all acting together, which appears to be 446 Pounds; the ſame which was demonſtrated by the joynt Action of only two Fibres.

139. By theſe Weights and Pullies, you may imagine all the Power which is exerted by every ſingle Fibre of a Plumiformar Muſcle, ſuch as G V P W (*Tab.* VI. *Fig.* 1.) to meet with a juſt and analogous Repreſentation.

150. For

150. For you may obſerve, that the Weight of 446 Pounds is as exactly equivalent to the Power exerted by this whole Muſcle G V P W, when you have ſuppoſed it made up of a thouſand Fibres, as when before, according to (61) we imagined it to conſiſt of only the two Fibres, G W and G V.

151. And from hence, by a little attention, what we have ſaid above, at *Prop.* 141. may appear exceeding plain and eaſie to any ordinary Capacity: Namely, that altho' the conſtituent Fibres of a Muſcle were imagined to amount to ten, or a hundred, thouſand, or the higheſt Number you can ſuppoſe, the very ſame Force, of 446 Pounds, will always, by theſe Methods of Calculation, be the reſult of the whole.

152. And to proceed yet further; we ſhall find the *Deltoides* exerting the very ſame Force; tho' we ſuppoſe (*Tab.* VI. *Fig.* 1.) to be an unjuſt Repreſentation, on the account of the Number of the Plumiformar Muſcles; tho' we imagine the *Deltoides* not to be confined to two, as repreſented by G V P W and H Z Q L; but contrary-wiſe, to be endowed with many of theſe Plumiformar Parts; yet we ſhall eaſily perceive, that the Force, or Power of it being calculated according to the foregoing Rules, the Whole will be exactly congruous to the Power or Force already demonſtrated.

153. And thus the Objection, which ſeemed to oppoſe this Hypotheſis with the greateſt Appearance of Reaſon, vaniſhes; and the Difficulties, under which ſome might labour to conceive the poſſibility of two ſuch Fibres, as G W and G V, being able to ſupport together 446 Pounds, or each of them ſingly half of that Number, are quite cleared and taken away: Eſpecially when it is conſider'd that we have only all along laid theſe things down by way of Suppoſition; but

but by theſe *Data* however, the whole Force of the Muſcle comes to be exactly accounted for. The Conſequence proving the ſame, whether we ſuppoſe the Muſcle conſtituted of a Million of Fibres (as in all appearance there are a vaſt Number) or of only two.

Let the Figure or Structure of theſe Muſcles be what it will, this Method may ſerve for a Sample to ſhew by what Methods their Power and Force are to be inveſtigated.

154. In all theſe Reflections, *viz.* on the prodigious number of Fibres; on the curious and peculiar form of the Muſcles, which repreſent Feathers joyned to a Tendon, as to a Quill (on which Topick conſult *Tab.* V. *Fig.* 10. where the Structure of the *Deltoides* is drawn from STENO's *Myologia*); and, laſtly, on the prodigious and almoſt incredible Force exerted by them; in reflecting, I ſay, on all theſe things, the adorable Wiſdom of the Great Creator muſt moſt ſingularly manifeſt it ſelf.

Steno repreſents the *Deltoides* conſiſting of 12 ſingle Muſcles; that is ſix Plumiformar Muſcles on each ſide: And if you imagine the empty White-Spaces, above and below, to be full of carnous Fibres (as *Steno* affirms, *p.* 53.) how vaſt muſt the Number be conceiv'd to be? And as to the Force, which *Steno* demonſtrates them to exert, according to his form, it cannot be much leſs than he aſſerts. But we have choſen rather to follow *Borelli* in our Repreſentation, according to *Tab.* VI. *Fig.* 1.; becauſe by this means we apprehend our Demonſtrations better adapted to Capacities unexperienced in Mechanics.

155. But to penetrate further into the prodigious Number of the Fibres, and to diſcover, as far as poſſible, the wonderful Deſign of the Creator, we need only obſerve (to keep to the inſtance of *Tab.* VI. *Fig.* 1.) that the two Fibres, G W and G V, are

are found to Balance ſeparately, a Weight of 223 Pounds (59) that is jointly 446 Pounds; as they repreſent together, the whole Plumiformar Muſcle G V P W.

If now, inſtead of two Fibres, we ſuppoſe (143, *&c.*) this Muſcle to comprehend 1000 Fibres; each of theſe thouſand Fibres will bear $\frac{446}{1000}$ of a Pound; that is not half a Pound to each Fibre.

And if the Number of Fibres were to be imagined greater, the Weight aſcribed to each, to bear for its Portion, wou'd prove much leſs: Or if the *Deltoides*, according to *Tab.* V. *Fig.* 10. inſtead of two Muſcles comprehended ſix (154); each Muſcle could then have its ſhare or burden, but $\frac{1}{6}$ of 446 Pounds, which is not quite 150 Pounds each: Thus the 1000 carnous Fibres conſtituting each Muſcle, cou'd have to its ſhare no more than $\frac{446}{6000}$ or $\frac{1}{13}$. of a Pound.

156. Now who, apprehending this Structure of the Muſcle, can think on it without acknowledging the Wiſdom of the Creator? Who has made the Tendons tough and ſtrong enough to bear, without breaking, the Violence of the Force which they are obliged to ſuffer in exerciſing the Qualities they are endowed with: At the ſame time, having regard to the Safety of the moſt fine and tender Fibres, by laying no more ſtreſs upon each of the Fibres in its Office than it is, by the Aſſiſtance of ſuch a multitude of its Fellows, able to ſuſtain, without the leaſt Injury.

157. For the Weight which each Fibre ſuſtains will be much leſs than $\frac{1}{200}$ of a Pound (155) if the Number of Fibres in each Plumiformar Muſcle much exceeds it (as tis probable they do) 1000; which was what we ſuppoſed (155) them to be.

It would therefore be worth any ones trouble to inveſtigate the number of Fibres in each Muſcle, as near as poſſible; not only to clear the determinate Number of Fibres compoſing each Muſcle (which might be done by thoſe who with accuracy pry into diſſected Humane Bodies) but alſo to adjuſt exactly how many of theſe Fibres, placed breadthwiſe, may be contained within the ſpace of an inch. *Borelli* ſays (§. 115.) that 50 Fibres thus placed, will ſcarce amount to an Inch: And as to the Number of Fibres in each Muſcle, we may judge, from the Fleſh of Beaſts, that many of theſe carnous Fibres make but a ſmall Portion of ſuch Muſcular Fleſh as we daily uſe in Food.

158. We ſhall ceaſe to admire at what is advanced in *Tab.* VI. *Fig.* 1. concerning the Poſition that is here laid down, *viz.* that one ſole little Machine, G M, of the Fibre G W (and ſo of the other Fibre G V) is able to ſupport 446 Pounds, when we conſider what follows:

The foregoing Propoſitions have made appear that the ſtreſs laid on each Machine, as G M, bearing not more than its Fibre G W, will not amount to $\frac{3}{10}$ or two Ounces and a half.

159. Thus the ſwiftneſs of the Motion imparted to the Weight T, by the contraction of the little Machines A B C, *&c.* (*Tab.* VII. *Fig.* 1.) when each of them are drawn up into the form of *a*, *b*, *&c.* will not appear ſo improbable; ſeeing that if there were no Weight, ſuch as T, ſuſpended, the concluſion (*viz.* that the Fibre to which T is ſuſpended, muſt riſe with the Velocity above-mentioned) wou'd be in it ſelf the moſt obvious thing in the World: Becauſe, by the foregoing Propoſition, the weight is repreſented ſo ſmall, that a ſingle Fibre or Hair, can be put to no great ſtreſs to bear it; eſpecially, conſidering that it has been already declared, that the Weight of 223 Pounds aſcribed

fronting page 192

TAB. VI

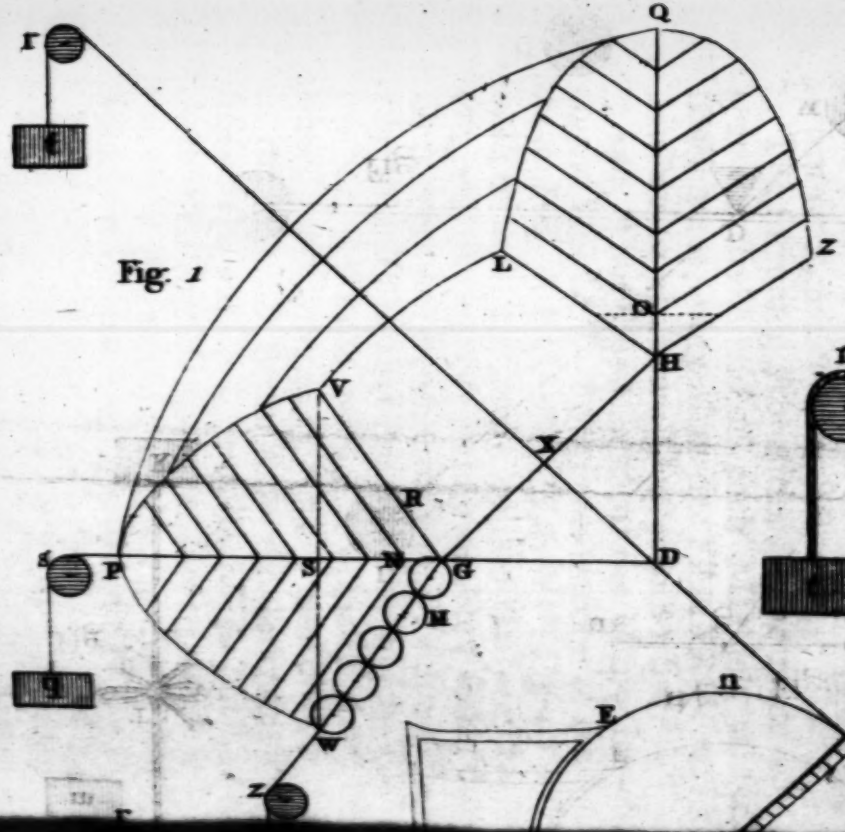


Fig. 1



Fig. 2

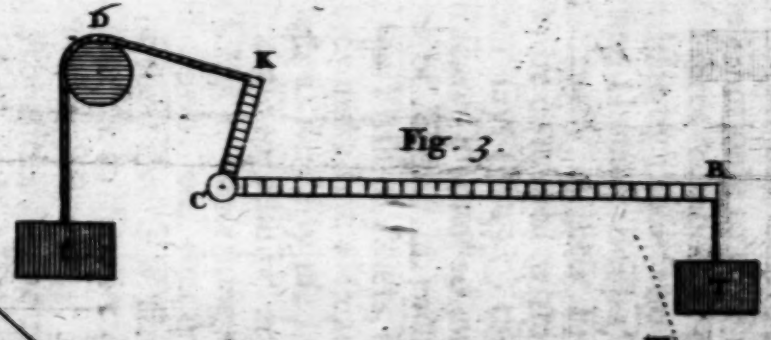


Fig. 3



Fig. 6

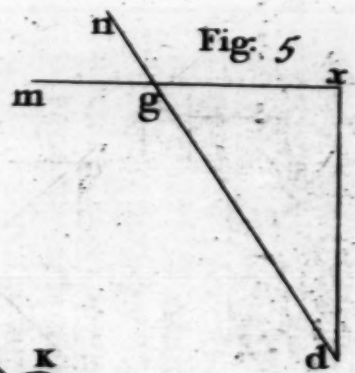


Fig. 5

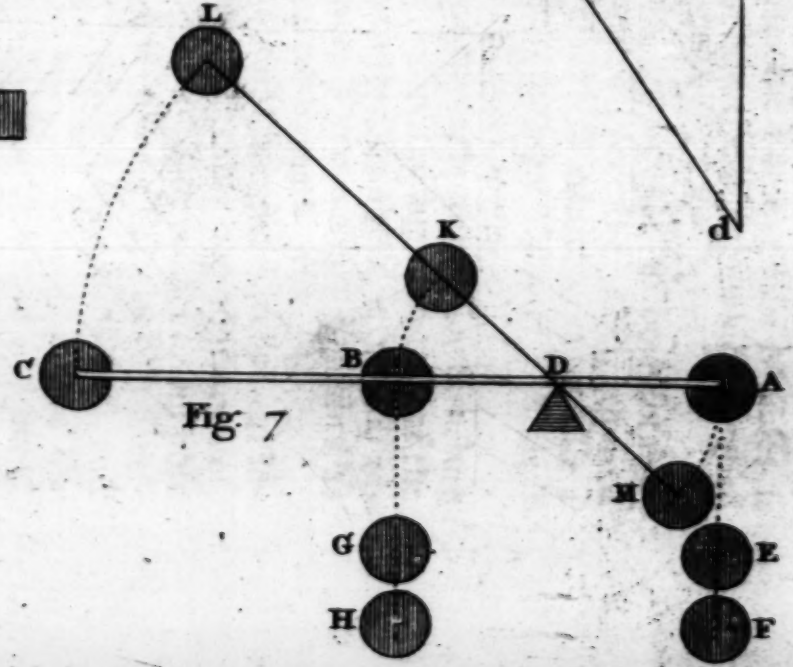


Fig. 7

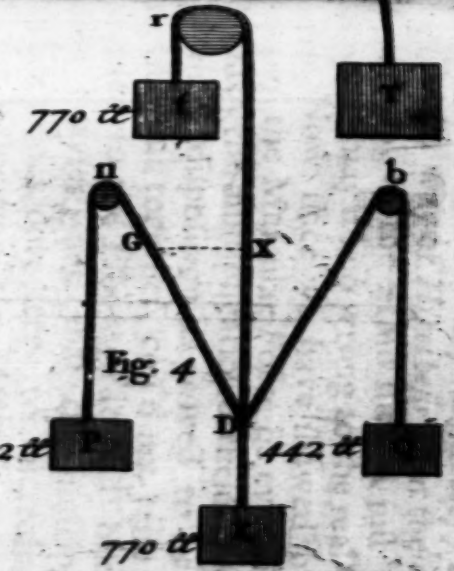
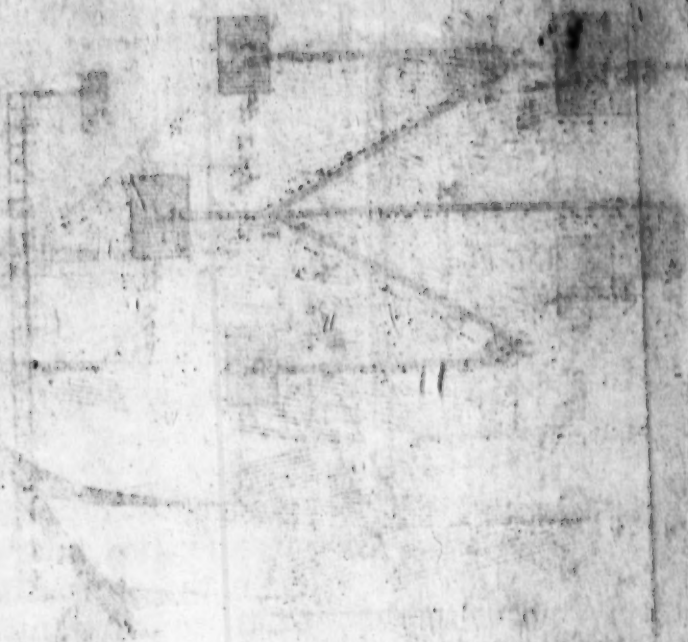


Fig. 4



aſcribed (59) to a ſingle Fibre (which is the chief thing that can raiſe any Difficulty) is only thus ſuppoſed by way of *Hypotheſis*; for the conveniency of conveying to the Mind ſuch a juſt Idea of the Matter, as may do no wrong to the real Calculation.

160. Now ſince we have ſhewed before (109) that tho' the Muſcular Force be ever ſo much augmented by the multiplication of theſe little Machines; yet, their diſpoſition is proved to be ſuch, that they all acting together, cou'd not raiſe the Weight ſuſpended to the Elbow if it had been but one Pound heavier; and that the multiplying theſe Machines does only ſerve to encreaſe, or multiply, the Velocity of the Motion.

Therefore Perſons not thoroughly acquainted with Mechanics may yet, ſeem to queſtion, how it can be poſſible that the Force of the Muſcles is really augmented, when the Weight which is raiſed is in no wiſe encreaſed.

To anſwer this, they ought to be informed, that a really augmented Force is as much required to encreaſe the Velocity of Motion, as to raiſe a greater Weight with the ſame Velocity: This is what all Mathematicians know.

This alſo is made appear by the Pulley Structure (*Tab.* VII. *Fig.* 4.) where the augmentation of the Velocity with which the Weight T is raiſed, requires each time more Force and new Weights, as *n*, *n*, *&c.* See the 5*th* Remark, 102.

161. That this obtains in other Mechanical Inſtruments, is what Mechaniſts are convinced of, and what may be eaſily obſerved: For ſuppoſe (*Tab.* VI. *Fig.* 7.) A B to be a Balance or a Steelyard, turning about D, and the Arms A D and A B to be equal; as alſo, the Weights A and B: 'Tis very plain, that the ſaid Steelyard A B being turned into the Poſition M K, the Weight A will run down the Arc A M, and the Weight B

down the Arc B K in the ſame ſpace of time
and that the Arcs being equal Parts of the ſaid
Circle, they muſt likewiſe move with equal Velo-
city.

Therefore if the Weight B were to be balanced
when its Gravity is encreaſed thrice as much as i
was, or when two equal Weights G and H are adde
to it, the Weight A muſt neceſſarily be aſſiſted b
two others of equal Gravity, or have its Force
multiplied by three, as we ſee it has when th
Weights E and F are added to it. Again, if w
wou'd make B move with a Velocity three time
as ſwift as it had before, let the Point B be re
moved to C, ſo that D C may be thrice as long a
D B: Wherefore, when the Machine turns, an
A deſcribes the Arc A M, the Weight C wi
deſcribe the Arc C L, in the ſame ſpace of time
which being thrice as great as A M, therefo
the Weight C runs thrice as ſwiftly as A or B.

But to balance this Weight C, when it move
thrice as faſt as B, it is plain that the Weight
muſt be multiplied by three, or receive the Add
tion of two other Weights, each equal to itſel
ſuch as E and F; otherwiſe it cannot raiſe up t
Weight B, which, placed at C, is equal to B G H
which happens on the account of that Velocity, r
ceives a threefold Augmentation.

Thus the Objection ſtarted in *Prop.* 160 is r
moved.

162. Before I conclude, 'tis incumbent on m
to beg that the experienced Mathematicians w
excuſe my Prolixity; not only in the Demonſtr
tions themſelves, but in conſuming Time to anſw
ſuch frivolous Objections as might be ſtarted
Perſons unexperienced in theſe ſorts of Studie
which renders the whole too long and tedious
expert Judgments.

B

fronting page 194

TAB. VII

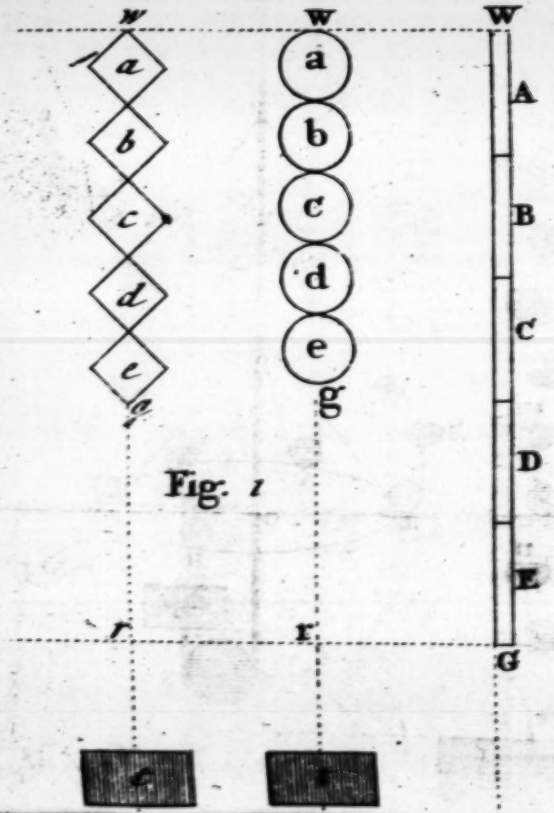


Fig. 1



Fig. 2

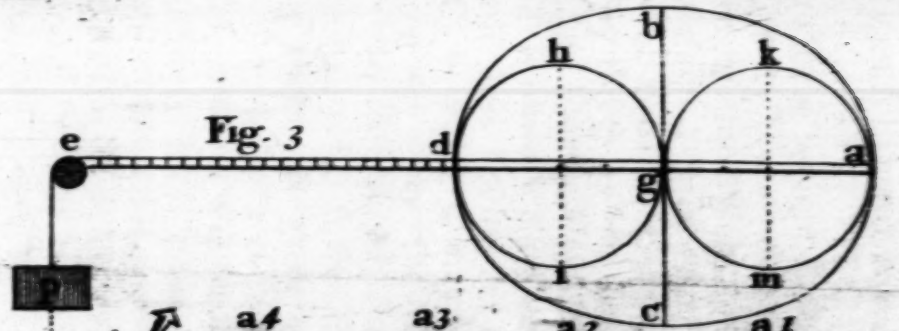
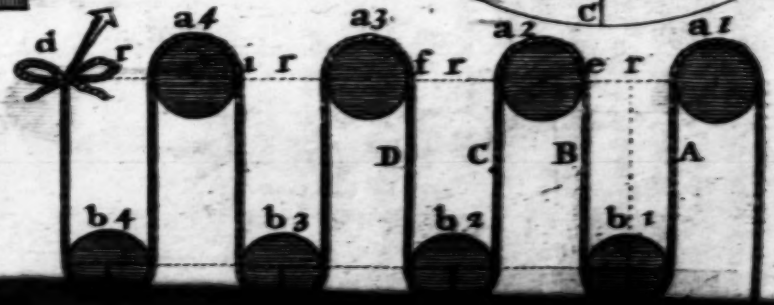


Fig. 3



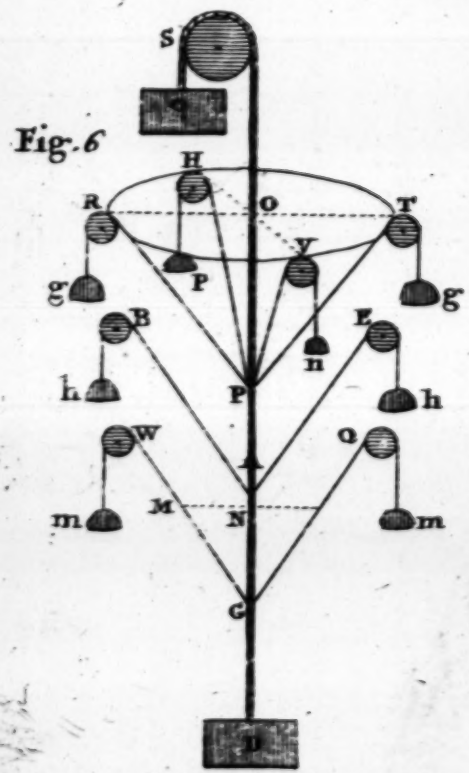

S
H
R
O
T
V
P
g
g
B
E
n
h
h
P
W
Q
m
M
N
m
A
C
D

Fig. 6

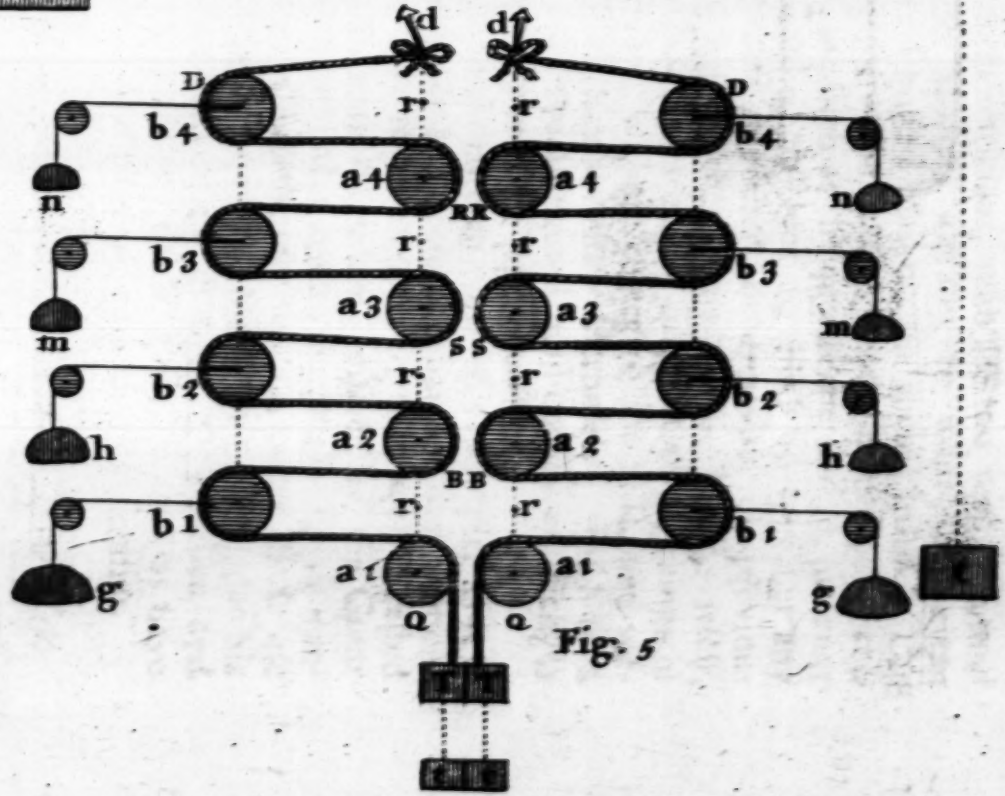

d
d
D
D
r
r
b4
b4
a4
a4
n
n
RR
b3
b3
a3
a3
m
m
SS
b2
b2
a2
a2
h
h
BB
b1
b1
a1
a1
g
g
Q
Q

Fig. 5

But if they'll pleaſe to conſider, that this Calculation is wholly devoted to the uſe of unexperienced Perſons, and not calculated for the Taſte of nice Mathematicians, who are too well informed in theſe Matters already, to want ſuch mean Helps; I hope I may obtain their Pardon. The Perſons for whom theſe Demonſtrations are collected, are ſuch as being unexperienced, have not habituated themſelves to heap up together any conſiderable Number of *Lemmata*, or previous Proofs, before they come to the Matter itſelf, whoſe Judgments cannot be informed in things of this Nature, without enlarging the Stile, and deſcribing Particulars more Verboſely; which is a Means, I have imagined, will convey my Deſigns more plainly to their Apprehenſions.

They that deſire to view this Matter, as it is more expreſly and accurately handled and Demonſtrated, may have recourſe to that well digeſted Work, *De motu Animalum*, written by the Great and Celebrated Mathematician, *Borelli*: whoſe Principles and Obſervations we have here made uſe of; endeavouring in the mean time, to render his Demonſtrations intelligible, by the conciſeſt and eaſieſt Methods we coū'd deviſe, to ſuch as have but little Knowledge of Mathematical Studies.

The End of the Demonſtration of the Force of the Muſcles.

Sect. XVI. *The Different Courſe of the Muſcular Fibres.*

In order to have a juſt and true Notion of the various and different Courſes of the Fibres, we ſhall repreſent to you a few Inſtances in *Tab.* VIII. *Fig.* 1. where, in the Muſcle called the *Deltoides* A, you may obſerve the Fibres faſt'ned imoveably upon the Shoulder C, and to the Tube or Bone of the Arm turning to the Joint of the Shoulder at D, letting the Arm hang downwards, as it is ſhewn here with all its Fibres extended in their utmoſt Length. But when theſe Threads between C and D are contracted with any Force, as you may ſee them in the other Shoulder at B; then the Arm muſt be lifted up, as at B E.

The Pectoral Muſcle K, being likewiſe here inſerted in the Breaſt-Bone, with one end of its Fibres at F, immoveably, and with the other end D, in the Tube or Bone of the Arm, moveably; it appears, that upon the Contraction of the ſaid Fibres they would draw the Arm, bending it at the Shoulder Joint forwards to the Breaſt.

If we view the Courſe of the Fibres in the Muſcle called the *Latiſſimus dorſi* A, A, (*Tab.* VIII. *Fig.* 2.) on each ſide, it appears that they draw the Arm downwards and backwards; for which reaſon *Anatomiſts* give it the name of *Ani-Scalptor.*

In the *Gaſterocnemii* B B, which lie in the Calf of the Leg, and are faſt'ned the one above, about the Knee at one end, as the other is below to the Heel-Bone by a ſtrong Tendon C; it may be obſerved, that the Fibres run ſtrait downwards, wherefore upon the contracting thereof, the Heel-Bone muſt be moved backward and upwards, and the Foot downwards. If one lifts up the Heel-Bone, and lays ones Hand upon the Calf of the Leg, one may feel

feel the Muſcles ſwell and contract themſelves in that Place. Theſe few Inſtances may ſuffice to give any one a general Notion of the Motions of the Muſcles by the Deſcription of the Courſe of the Fibres whereof they are Compoſed.

Sect. XVII. *Convictions from the foregoing Obſervations.*

This wonderful Structure of the Muſcles ſeems to me of too great Importance not to place them before the Eyes of ſuch as are unexperienced in Anatomy, by the two Figures of the Muſcles, as they lye upon a Human Body, before and behind. (*Tab.* VIII. *Fig.* 1, and 2.) taken from Dr. *Brown.*

CONTEMPLATION XI.

Of the Bones.

Sect. I. *The Tranſition to the Bones.*

NOW whatever Art and Wiſdom appears in what has been ſaid concerning the Body; and with whatever Luſtre the things hereof may ſhine, how neceſſary and uſeful ſoever all its Veins, Nerves and other Parts may be; yet all this amazing Structure would be in vain, and the whole Body, like a wet Sack, would cling or ſtick together, and conſequently hardly be in a Condition to exert any one Motion with Regularity, nor yet be able to remove one Foot out of the place it was in; (wherefore it might perhaps have repreſented an Ingenious and Well-compoſed Machine, but yet at

the ſame time would be really nothing more than a very uſeleſs, weak, and pitiful Lump,) unleſs the Gracious Creator had at the ſame time vouchſafed to ſupport it by the Stiffneſs and Hardneſs of Bones, and ſo render it proper to diſcharge its Functions.

Sect. II. *The Scull and Bones of the Head.*

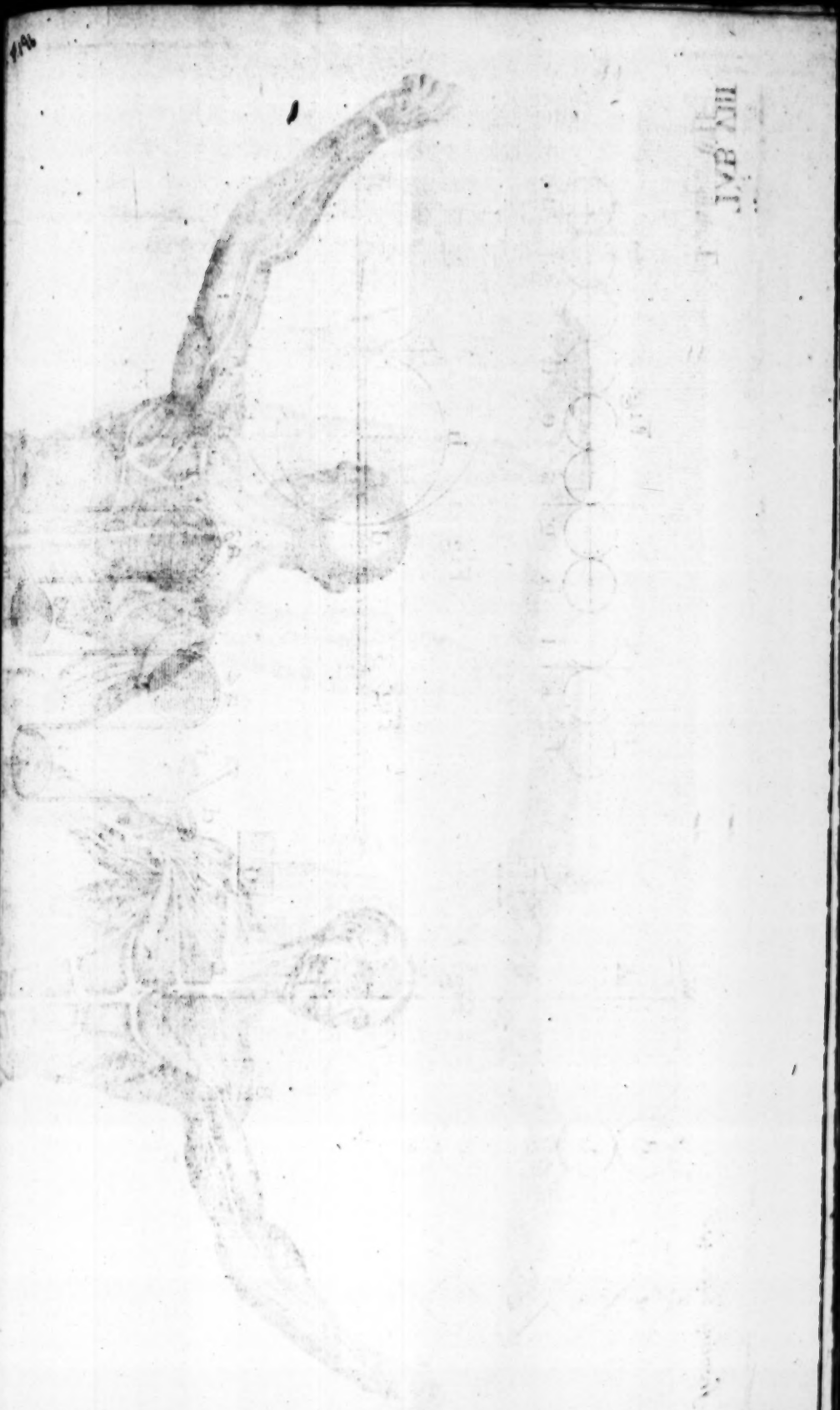
Tho' the Remarks that *Anatomiſts* have made upon Bones are numberleſs, we ſhall only here produce a few of the chiefeſt of 'em. And,

1. Can it be thought there was no Wiſdom exerted, when we conſider that the Brain being of ſo ſoft a Matter, might have been eaſily preſſed and wounded by external Accidents, to the hazard of our Lives; to prevent the ſame, it is cloathed and encompaſs'd with a hard Subſtance made of Bone, which we call the Skull?

2. That this Skull does not conſiſt of one only hard Piece, but of ſeveral Parts joyned together, which may be divided by a kind of intervening Sutures, to the end that they may be moveable and yielding in unborn Children, at the time of their Mothers Delivery; for want of which, Mother and Child might both Periſh.

3. That ſuch Moveableneſs ceaſes as the Children grow in Years, when it would otherwiſe be Prejudicial, and then the Principal uſe of thoſe Sutures, is to maintain a Communication between the Membranes that encompaſs the Brain and the Skull.

We ſee a great Proof thereof from hence; foraſmuch as at the Top of the Head where the Sagittal and Coronal Sutures croſs each other, there is found an Opening between the Bones, which in New-born Children is all cover'd with a Membrane, upon which, if you lay your Finger, you may



fronting page 196

TAB. VIII

Fig. 1

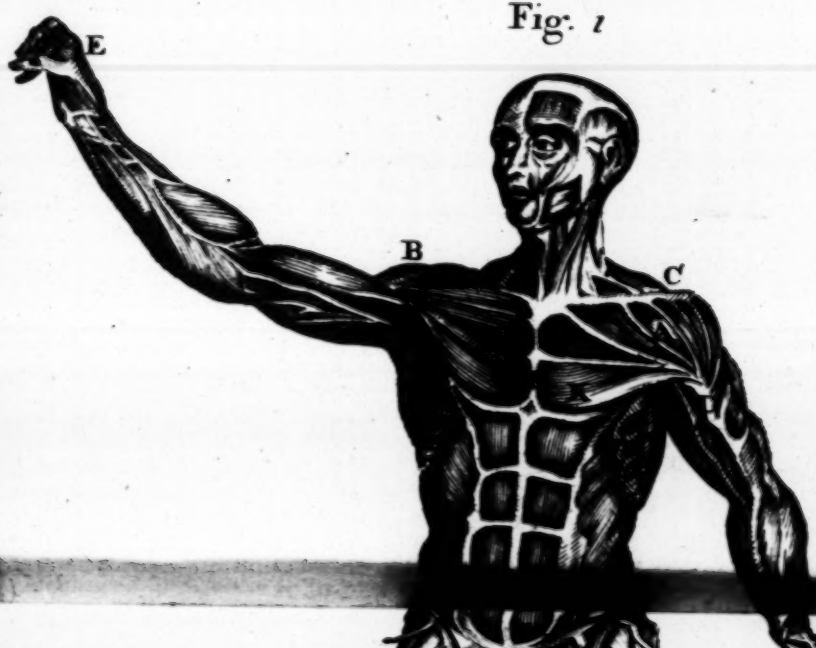
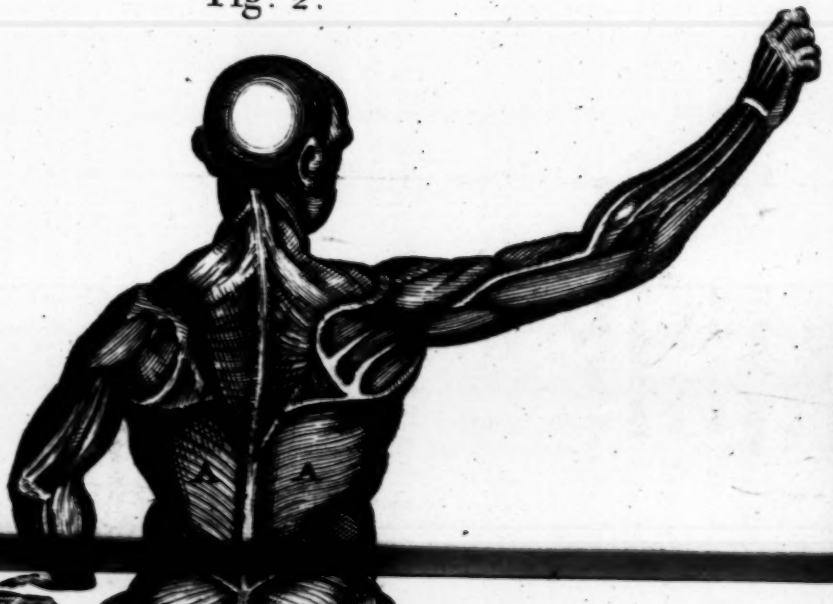
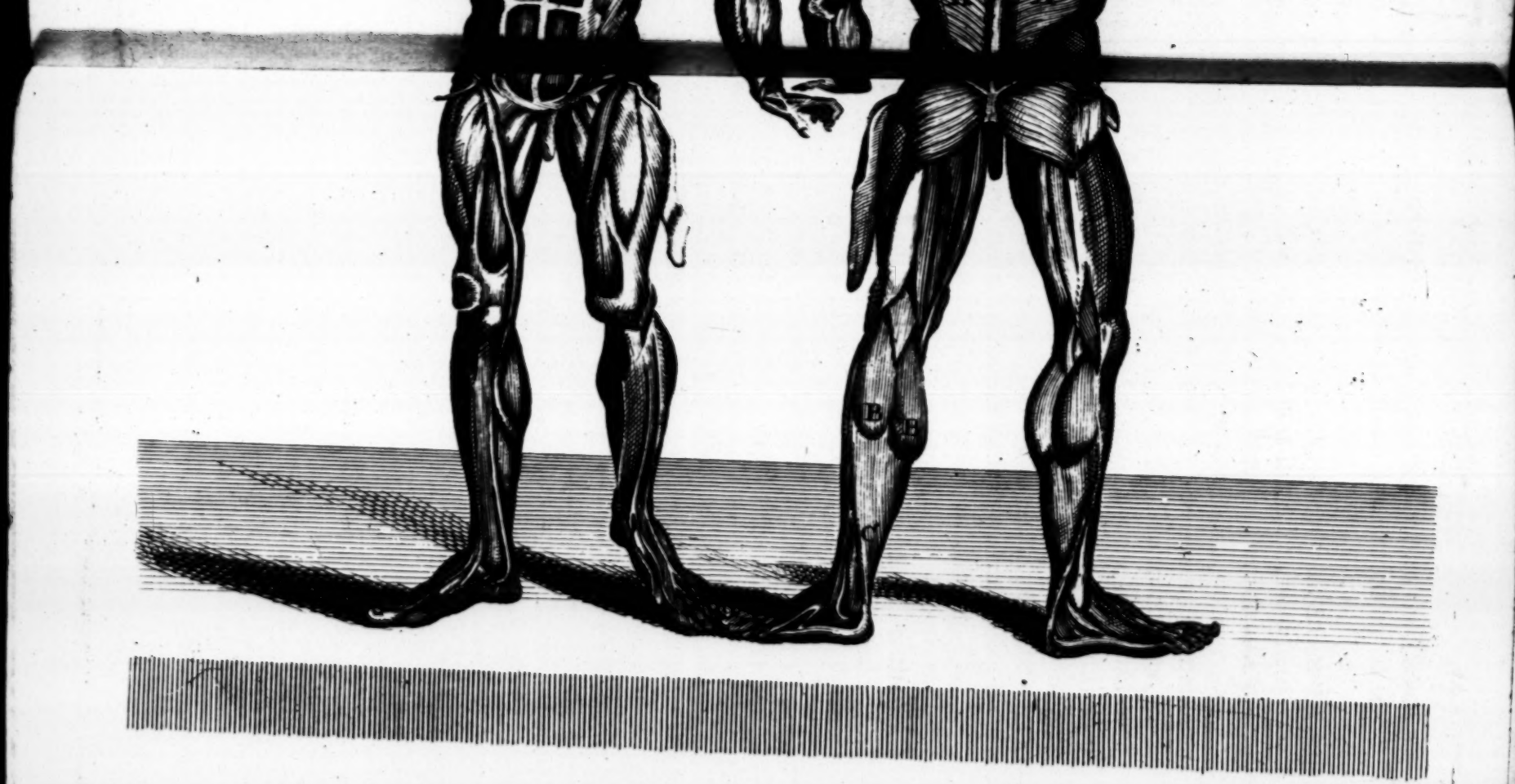


Fig. 2.







may perceive the beating of the Parts in the Head; but in time the ſame is filled and cloſed by a ſolid Bone.

4. That the Skull, tho' every where of ſo ſolid a Subſtance, has yet holes in it in all Places where it is neceſſary, to afford a Paſſage for the *Medulla Spinalis* and Blood Veſſels from the Brain; particularly, that there are found in the Ears ſo many Angles and Cavities, artificially hewen out, as it were in Bones as hard as Rocks, for the Reception of the wonderful Inſtruments of *Hearing*, placed in ſuch an order as they appear to us.

5. That there is an Orifice in the upper Cheek-Bone, thro' which the Air paſſes by the Noſe into the Lungs; and for want of which, no Child could eaſily ſuck, nor full-grown People themſelves, keep any Liquor or moiſt Food long in their Mouths.

To ſay no more, it is obvious enough to every one, how great the Inconvenience would be, if a Man were forced to Breath thro' the Mouth only, and not thro' the Noſe.

Now thoſe who would take the farther trouble of conſidering the Bones of the Head in the minuteſt Circumſtances thereof, and learn from Anatomy the Uſes which the Diligence of Enquirers has hitherto diſcovered; might ſee, that among all the Number of them, that there is no Part, no Cavity, no Orifice, tho' ever ſo ſmall, but what has its neceſſary Uſe; and that not only for the Eaſe and Well-being, but even many times for the Support of our precious Lives.

Sect. III. *The Back-Bone.*

But now as the Brain is encompaſs'd with a Bony Caſe, that it may not eaſily be affected by any external Inconvenience; the like Defence ſeemed to

to be not leſs neceſſary to the *Medulla Spinalis* againſt all outward Harms; for that conſiſting of the Soft Matter of the Brain, muſt be carried downwards in order to communicate the Spirituous Juice thereof, by the Nerves to many Parts.

To this purpoſe a hollow Tube of Bone, like that of the Leg, ſeems to have been ſufficient, becauſe it might have contain'd and ſecured the ſame againſt external Violence; but on the other hand, there occur'd an Inconvenience which muſt be prevented, namely, that the Body would remain as immoveable as if a Stake were run thro' it, and be entirely diſabled from bending it ſelf in any manner.

And again, if Joints had been made in this Tube that includes the Spinal Marrow, ſuch as are in the Elbow, Fingers, *&c.* the following Inconveniencies would have happen'd.

Firſt, That the Parts of this Tube making ſmall Angles with each other, or being entirely bent down towards one another, the *Medulla Spinalis* muſt have followed ſuch an Inflection, and the Courſe of the Nervous Juice would have been obſtructed by theſe accute Angles; which of how great Conſequence it is, is well known to thoſe, who by the like Obſtructions have not only fallen into Lameneſs, but even Agues, Putrefaction and Rotteneſs of the Bones, and have loſt their Lives too thereby.

Secondly, Tho' none of theſe Inconveniencies ſhould happen, yet the Body might by ſuch ſort of Joints be bended forwards, and in ſome manner backwards too, but by no means ſide-ways, as is plain in the Elbow and Fingers.

Indeed if Articulations were to be made like thoſe of the Shoulder or Hip; and that the *Os Rotundum*, or Knob of one Tube, ſhould turn or be moved in the Cavity of the other, it is eaſie to ſee that the Inflection would happen on all ſides:

But

But it is likewiſe true, that the Spinal Marrow could not ſuffer more in any Diſpoſition; foraſmuch as being obliged to run thro' the Thickneſs of ſuch a Bone, it could not avoid being ſtraiten'd and preſſed by the Motion thereof, and ſoon render'd unfit for its Uſes.

To prevent all theſe Inconveniencies, and to render the Body flexible on all ſides, and yet to avoid ſuch Conſtriction of the *Medulla Spinalis*, by making ſome little Angles; and chiefly to ſecure the ſame quite round, againſt all Occurrences, let the moſt skilful Engineer, or the greateſt Mathematician, conſider with himſelf, whether he could better ſolve this important Problem in Mechanicks, and attain all theſe Ends by a more perfect Structure than that which the adorable Wiſdom of the Great Creator does here ſet before us. Thoſe who deſire a ſhort Conception thereof, let them view *Tab.* IX. *Fig.* 1. where the Back-Bone is repreſented, conſiſting of a Number of little *Vertebræ* placed upon one another; each of which has a great Hole in the middle, in order to let the Spinal Marrow paſs thro' it, by which means all of them together compoſe a hollow Tube from Top to Bottom; which being inflected, either right forwards or on either ſide, do, by reaſon of the ſmallneſs of the ſaid *Vertebræ*, ſcarce make any Angles, or very little ones: In the ſame manner as it were, as in the Multangular Figure A E B, F, C, G, D (*Tab.* XI. *Fig.* 2.) in which we ſee little and inſenſible Flections, where if the ſides were made a little ſmaller; or, if inſtead of A E, two or more other ſides were taken, the Figure would be very near Circular; that is to ſay, without any Angles at all, at leaſt, any that are perceptible to us.

Now, ſince it appears from hence, that if we inſcribe a Polygone in a Circle of fewer and

and greater ſides, as A B, B C, C D, the Angles A B C, B C D, *&c.* are much leſs and more acute than the Angles A E B, E B F, *&c.* which are made when the Circumference of the Polygone Figures conſiſts of more and ſmaller Parts: We ſee likewiſe, that to prevent ſuch acute Angles, it was here neceſſary, that the *Vertebræ* ſhould be very ſmall, and therefore very numerous.

Sect. IV. *The Uſes of this Structure of the Back-Bone.*

Now can any one imagine that the Diviſion of this Tube into ſuch ſmall Parts as thoſe of each *Vertebræ* (which was juſt neceſſary in this place and no where elſe) could have been made only here and in no other Parts of the Body, without the wiſe and premeditated Purpoſes of a Great Creator?

Moreover, becauſe this Back-bone was not to be moved by Joints, but inflected without Angles, we ſee in the Figure above-mention'd, how this is moſt regularly brought about, by faſt'ning each *Vertebræ* to the next above and beneath it by an intervening Cartilage; from whence the three following and ſo neceſſary Uſes do reſult:

1. That by the intervention of ſuch a Cartilage the *Vertebræ* are hinder'd from rubbing and wearing out each other.

2. Foraſmuch as in the bending the Back-Bone (on the Right ſide for inſtance) the *Vertebræ* on the ſame ſide muſt be brought nearer to each other, and upon the Left and oppoſite ſide at the ſame time muſt recede farther from each other: That this Cartilage has ſuch a Faculty as to be able to ſerve for both Purpoſes, and to permit that the Back-Bone, by the mutual approach of the

the *Vertebræ* at the times of bowing or bending on the Right ſide, are preſſed ſomething cloſer together, and ſo render'd as it were Thinner; and at the ſame time on the Left ſide proportionably extended, and ſo became as it were Thicker.

3. And that which is particularly required here, is, that this Cartilage ſhould likewiſe have an *Elater* or Expanſive Faculty, which, upon its being compreſſed on the Right ſide, ſhould cauſe it to riſe up again; and when extended on the Left ſide, ſhould likewiſe contract, or draw it in again.

Thus this Cartilage is not only proper to render the Inflection of the Back-Bone eaſie and convenient; but likewiſe to exert itſelf with a ſenſible Force for the Reduction of the ſame into its natural State after Inflection: The greateſt Mathematicians having enquired into this with the utmoſt Diligence, have been obliged to acknowledge it for a wonderful piece of Work. *Borelli, Par.* 58. *De motu Animalium* calls it *Artificium Structuræ Spinæ Dorſi*, or the *Artificial Structure of the Back-Bone*, and begins his Enquiry by aſcribing theſe and ſuch like Matters, to the *Wiſdom of the Divine Architect.*

Sect. V. *The Whirl-Bones.*

We ſhall paſs by the Wonders that might be obſerved in the Eminences or Heads of the *Vertebræ*, into which the Muſcles are inſerted for Motion; and in the Holes that are therein for a Paſſage for the Blood Veſſels; as likewiſe the Cavities that are between every two *Vertebræ*, and thro' which the Nerves that are derived from the *Medulla Spinalis*, paſs to their reſpective Parts: the leaſt of all which may furniſh us with ſufficient Matter of Aſtoniſhment at the Wiſe Deſigns of the Creator.

Par-

Particularly the Structure of the two higheſt *Vertebræ* of the Neck is very wonderful, which, becauſe the caſe does here require it, and to the end that the Motion of the Head may not be obſtructed, are each of 'em of a different Figure; and the ſecond of 'em has an Eminence which ſerves for a Pin, upon which the Head may turn by the means of the firſt *Vertebræ*. He that deſires to be farther inſtructed herein, may conſult the Books of *Anatomy* which are in every ones Hand; and if he be in earneſt in his Enquiry into the Glory and Greatneſs of his Creator, make the right uſe thereof.

Sect. VI. *The Ribs.*

Not to dwell too long upon the uſe of the Ribs, which form the Space and Cavity of the Breaſt, in order to leave room enough for the Heart and Lungs to move in, and at the ſame time to defend the latter from all External Violence: Let any one ask himſelf, whether it be owing to *mere Chance*, that theſe Ribs, in the part where they are faſt'ned to the Cartilaginous Breaſt-Bone, are likewiſe compoſed of a Cartilaginous Subſtance, to the end, that when they move at Reſpiration or drawing in of the Breath, they may be more eaſily inflected by the Muſcles; and after that the Operation of the Muſcle ceaſes, they may, by their own Elaſtick Force, return to their former State, and thereby contribute very much towards Breathing.

Concerning their Power and Action, you may ſee what the Learned *Borelli* has ſaid in his Second Part.

Sect.

Sect. VII. *The Hip-Bones.*

To mention curſorily the reſt of the Bones, and particularly the Hip-Bones, with whoſe moſt neceſſary Service we ſhould be ſufficiently paid, if they were of no other uſe only, than to ſecure and ſtrengthen the Wombs of Women, from whence all Mankind receive their Birth; beſides, that they afford both to Men and Women an immoveable *Fulchrum*, or Support, to the Thighs, Legs and Feet in bearing the whole Body: It ſhould ſeem therefore that nothing remains, but to give ſome account of the Structure of the Arms and Legs, of which, as alſo of their Articulations and Joints, ſomething has been already ſaid in our *Contemplation of the Muſcles*, ſince it was impoſſible to treat of theſe laſt with any manner of Clearneſs, without ſome knowledge of the former, to which therefore, if any one thinks it neceſſary, he may have recourſe.

Sect. VIII. *The Thigh-Bone.*

Let then a Philoſopher that is enquiring after Truth, take into his Hands ſuch a Thigh-Bone as we have deſcribed (*Tab.* IX. *Fig.* 3.) A E, and ſuch as he may have met with many times in Church-Yards and Charnel-Houſes, without taking any notice thereof, and he may ſee in this alone, the great Creators wonderful Direction to ſo many neceſſary Uſes. For he will find, *firſt*, that the ſame is very hard and ſtiff to enable it to bear the Body; but at the ſame time hollow, that it may not incumber the Motion thereof by its Weight; and at the ſame time to be provided with a Marrow, that is ſo neceſſary, and to keep it ready for the Service which it is to perform, of which hereafter.

Secondly,

Secondly, That in *Tab.* IX. *Fig.* 4. the Knob or Head of the Bone A is round, and is ſo accurately adapted to the *Os Iſchii*, or Hip-Bone B, that it can turn round therein, and be moved on all ſides.

Thirdly, To give ſome ſlight Deſcription of this Joint, ſince the Figure will help us therein; can we diſcover no Wiſdom in the following Particulars? *viz.* *Firſt*, this Knob A, is ſurrounded with a kind of a ſmooth poliſhed Cartilage, to the end that it may perform its Motion without Reſiſtance and without Pain. *Secondly*, that to give the greater Steadineſs to the Joint, this round Bone A, is faſt'ned in the Cavity as it were with a Rope or Tendon, by a Strong-band *b*, which however does not obſtruct its Motion. And *Laſtly*, that a broad Band, *a*, ſurrounding the whole Joint (but which in this Figure is repreſented as cut thorough) ties the whole together, ſtill preſerving the Freedom of Motion.

Fourthly, To proceed in the Contemplation of the aforeſaid Thigh-Bone (*Tab.* IX. *Fig.* 3.) it has two Eminences or Heads, D D, at the place where it makes a Joint with the Leg or Shin-Bone below at the Knee; which are both likewiſe encompaſſed with Cartilages, that they may ſlip the more conveniently and ſmoothly. Theſe two Heads, D D, or *b b*, in *Tab.* IX. *Fig.* 5.) have between them a pretty deep Hollow or Groove *e*, and are both adapted to two Cavities *c c*, which are above in the Shin-Bone K; and that again has an Eminence lying between the two Holes *c c*, which is likewiſe adapted, and enters, into the internal Angle *e*, between the Heads of the Thigh-Bone *b b*. Now, need we ſay any more to prove very evidently the Deſigns of the Divine Architect? And he, who in any wiſe comprehends it, muſt he not be convinced that this Joint is of a different Structure than that of the Thigh-Bone; and that it ought to be ſo for

foraſmuch as the Knee is only to be bent forwards and backwards, but by no means ſideways, as the Thigh-Bone, and that otherwiſe it would produce a very irregular Gate.

Fifthly, To ſay nothing of the Ligaments or Bands, which (like as in the Joint of the Thigh with the Hip-bone) preſerves all this from diſjointing: Nor likewiſe of the Knee-pan, the uſe of which is beſt known to them who having broken the ſame by any Miſchance, are thereby deprived of the chiefeſt Strength of this Joint.

Could any one ſee that the little round Bodies B and C (*Tab.* IX. *Fig.* 3.) are of ſo great uſe for the Inſertion of the Tendons of Principal Muſcles, and ſtill ſuppoſe that this Bone had acquired its Form without Deſign? In which, not one Eminence, not one internal Angle is to be found, which, if it had been of a different Structure, would not have occaſion'd remarkable Inconveniencies to Men.

If any Body would ſee the manner of ſuch a Structure at his Eaſe, he need only conſider the Claw and Leg of a *Pullet*, and that to which it is faſt'ned at both Ends, where he will find ſomething very analogous to what we have now deſcribed.

Sect. IX. *The Teeth.*

To the abovementioned account of Bones we might have added the particular Properties of thoſe whereof the Teeth are compounded, and how they differ from other Bones, to the end they may be the better adapted to their own Uſes. Now in caſe they had been produced by Chance, or by Cauſes operating without Underſtanding, why are theſe Bones exactly provided with the different Qualities which they themſelves required?

And why do they ſo ſeldom appear in the Mouths of Young Children in the firſt Months, when they would be both inconvenient to the Sucking Child and Painful to the Mother? And why are they produced at the time, when the Stomachs of thoſe Young Creatures are capable of digeſting more ſolid Food?

Thoſe who deſire to be informed of other Circumſtances about the Teeth, may conſult what has been ſaid above touching the Mouth, Chewing, *&c.*

Sect. X. *The Bones in unborn Children.*

The Diligence of Anatomiſts has diſcover'd many things in the Bones of Children before their Birth; and plainly ſhewn in ſeveral Caſes the difference there is between thoſe of a new Born, and of a Perſon in Years; yet it is ſtill unknown of what Matter they are compoſed at the Beginning, and afterwards in their Changes, till they have acquired their Solidity and true Nature; and particularly, what were the real Cauſes of the whole.

So that no Body who believes the Divine Origin of the Holy Scriptures will be ſurpriſed, that the adorable Spirit of God, with which the Writers thereof were endowed, has been pleaſed to make uſe of this Inſtance, to prove the Smallneſs and Narrowneſs of our Knowledge in theſe Matters, by the following Expreſſions, *Eccleſ.* xi. 5. *As thou knoweſt not what is the way of the Spirit, nor how the Bones do grow in the Womb of her that is with Child; even ſo thou knoweſt not the Works of God who maketh all.*

The Enquiries of the accurate *Malphigi*, when he treats of the wonderful Formation of the Bones of a Chicken in the Egg, are worthy to be conſulted

ſulted upon this Occaſion; but without going ſo far, the few Obſervations that we have yet been able to make in the Bodies of Men, do confirm experimentally, and plainly enough, theſe Words of *Solomon*; when we ſee the Great *Harvey*, who is ſo juſtly eſteemed throughout the World, on account of his famous Diſcoveries, thus ſpeaking in his Treatiſe, *de Ord. Part. in Generat. In the firſt Months ſome of the Bones are ſoft, others cartilaginous; the Arms ſo ſhort, that when laid upon the Breaſt the Fingers cannot touch each other; nor can the Legs, though folded upon the Belly, ſcarce reach to the Navel: And this comes from hence, that the whole Fruit has hardly the length of the Nail of ones Finger, till it comes to be about as big as a Frog or a Mouſe.*

At firſt, *there are formed little Fibres, or Threads, of the conſiſtency of Slime, which are afterwards nervous, then cartilaginous, and finally of the hardneſs of a Bone. In the ſecond Month* (according to the ſeveral Experiments of the abovementioned Author) *the Embrio is very big in its Head, and very ſhort in its Legs; and the whole Matter ſo ſoft and inconſiſtent, that it can hardly bear touching with the Hands; and in order to be examined, muſt be laid in Water; nor is there any Solidity in the Bones.*

Sect. XI. *The Bones are produced from a fluid Matter.*

Before we proceed farther, let the Reader conſider with himſelf, whether it can be thought, that an Over-ruling Power and Providence had no ſhare in this Matter, when he ſees hard Bones ſo wonderfully adapted to many Uſes, ariſing only from a Slimy Matter, which owed its beginning to nothing but Bread and Water?

For that the Bones, be they never ſo hard, do in a great manner ariſe out of a Fluid, is abundant-

ly proved by the Chymiſts, who having diſtilled the ſame quite dry, and without the addition of any Liquid Matter, do produce from thence a great Quantity of Oyl, and yet more of Watry Parts (in which their Volatile Salt is melted, and which therefore is called their *Spirit)* as is well known to ſuch as have made the Experiment.

Sect. XII. *Pſalm* CIX. *ver.* 18.

Now with how preciſe a Knowlede the Holy Ghoſt has ſpoken in other Places of Scripture, even of this internal Structure of the Bones, will appear as plain as the Sun at Noon, to ſuch as, from Chirurgical Experiments, have learnt, that there is nothing more pernicious to a naked Bone, than to put Oyl or any other Moiſture upon it, which will cauſe a miſerable Corruption therein: On which account it is, that the moſt skilful Surgeons, in treating about the Diſeaſes of the Bones, do moſt carefully warn the Readers againſt the ſame.

For an Inſtance hereof, one need only read the Words of *Hildanus*; *Ab omnibus autem humidis & oleaginoſis in denudatis oſſibus in quacunque corporis parte, planè ut abſtineat Chirurgus neceſſe eſt.* P. 816. *That is to ſay, a Surgeon muſt carefully abſtain from the uſe of all Moiſt and Oyly Matters in the managing of naked Bones, in whatever part of the Body they lie.* As alſo Mr. *Paré* ſays, upon the ſame occaſion, p. 560. *Moreover the Bones may be likewiſe Corrupted by the improper Application of any Oyls, or other Moiſt Medicines.*

I have only produced the Evidence of theſe two Gentlemen here, becauſe they may be juſtly ranked among the moſt Famous and Skilful Men in this Art.

For to return to the Matter again; Can any one that reads that Text in *Pſ.* cix. *ver.* 18. *As he cloathed himſelf with Curſing, like as with his Garment*

ment: ſo let it come into his Bowels as Water, and like Oyl into his Bones; and who has ever ſeen this *Caries Oſſium*, or Corruption of the Bones, in any conſiderable degree in a living Perſon, and has been informed that the ſame may be produced, or at leaſt augmented, by any Liquid or Oleaginous Matters, muſt needs confeſs, that the Wrath and Curſe of GOD cannot be deſcribed by more lively Compariſons, ſince Water and Oyl, that are mentioned in this Text, are both of 'em the moſt pernicious things imaginable to the Bones?

SECT. XIII. *Bones without Nerves.*

ACCORDING to the very Learned Anatomiſt, Mr. *Verheyen*, the Bones having no Feeling, are conſequently without Nerves, which are accounted by all for the Inſtruments of Senſation; but whether that be produced by their *Marrow*, *Juice*, or *Membranes*, we ſhall not here contend: The ſame is not obſcurely maintained by a famous *Engliſh* Anatomiſt, Dr. *Clopton Havers*, who, tho' he differs a little from the former, touching the feeling of the Bones, yet, in his *Oſteologia Nova*, or *New Deſcriptions of Bones*, p. 29. he affirms, that having enquired as nicely as poſſible into this Matter, he could diſcover no Nerves in the Bones, but endeavours to ſhew how this Abſence of the Nerves may be ſupplied; ſo again, ſpeaking of the Nerves of the Teeth, *p.* 102. he ſays, that *there be other Bones to which it ſhould ſeem that no Nerves do belong*

SECT. XIV. *Marrow.*

Before we conclude theſe Remarks concerning the Bones, we muſt ſay a word or two about the Marrow: Now can any one ſuppoſe that the Bones were made hollow without Deſign, ſince they

they ſerve for the Receptacles of a Fat or Greaſie Matter, which renders the Limbs ſmooth, and ſupple in their Motions, and prevents the Cartilages in the Joints, when ſliding upon each other, from being worn out or burnt by a continual Attrition, which wou'd happen if they ſhou'd remain dry, as appears in the Axel-trees of Waggons and Mills, which are greaſed for that very purpoſe.

Not to mention here, that by the ſaid Greaſe or Marrow, the Bones themſelves (which being otherwiſe too dry, would become brittle) and the Ligaments or little Bands thereof are kept in their proper Condition by ſuch a Moiſtúre; as we ſee the Muſicians Oyl the Strings of their Inſtruments, to the end that they may not break by too much Dryneſs.

How plainly then does the Wiſdom of the Great Creator ſhine forth in this very Matter, by contriving in ſo hard a Subſtance as Bones are, Ducts and Paſſages through which the Marrow may ooze out or *filtrate* from the little Tubes of the Bones into the Joints?

Sect. XV. *Water and Oyl together ſerve to render the Parts ſmooth.*

They that deal with Air-Pumps (the Conſtruction of which, to render the matter more intelligible to unexperienced Perſons, muſt be ſuppoſed to be like a great Syringe) know, that the Sucker thereof muſt be firſt ſteep'd into Water, to make it ſwell out to the neceſſary Thickneſs and Softneſs; after which it is oyled a little, that it may move backwards and forwards more ſmoothly and readily; from hence it is plain, that when the Sucker, tumified with Water, is thruſt with ſome Force into the Tube of the Air-Pump, which is narrower than the extended Sucker, the Water is preſſed out

and

and mingles it ſelf with the Oyl that was ſmeared over the Sucker.

Now could any Body, who has never made a trial thereof, (to add ſomething here which is very remarkable) imagine, that Water and Oyl thus mixed together, are much more proper than Oyl alone, to cauſe two Bodies, rubbing againſt each other, to move more ſmoothly and nimbly upon one another? And yet, that this is true, the aforeſaid Experiment has taught us; wherefore, it is likewiſe very uſeful, that the Sucker, already ſmeared with Oyl, ſhould be even once again dipt in Water, before it be thruſt into the Tube of the Air-Pump.

The firſt Obſerver hereof, was the great Mr. *Robert Boyle*, who, upon the account of his Enquiries into the Creatures, can never be ſufficiently praiſed; that Gentleman, in the Introduction to his *Phyſico-Mechanical Experiments, p. 7. of the Cologn Edit.* ſpeaks thus of this mixture of Water and Oyl, to render the Motion of his Air-Pump more eaſie: *Upon which occaſion we muſt not here omit (becauſe it appears ſo wonderful) that neither Oyl nor Water uſed ſingly, could bring to paſs that the Sucker ſhould be moved eaſily and readily; but that a mixture of them both (ſeveral times repeated to our great ſurpriſe) did produce the deſired effect.*

Thus we ſee that a Gentleman, who, if he can't be called the greateſt Philoſopher in the World, yet may juſtly be placed in the firſt Claſs of Great Men, acknowledges himſelf, that he could never have diſcovered this by Argumentation, but learnt it (*to his great ſurpriſe*, which ought to be well obſerved here) by Experience only.

SECT. XVI. *Oyl and Water thus mingled, inſinuate themſelves into the Joints.*

NOw let the Atheiſt, that has never ſo high an Opinion of his own Underſtanding, or the ſtrongeſt Mind (as they love to call themſelves) ſeriouſly conſider by himſelf, laying aſide all Obſtinacy and Paſſion, whether he can attribute all this, with the leaſt appearance of Reaſon, to *meer Chance*, or *ignorant Cauſes*; when he ſees with his own Eyes, that in order to render the Joints more ſupple and moveable, and to produce ſuch a mixture of Oyl and Water as would be fit for that purpoſe, there are found, in and near the ſaid Joints, perpetual Springs and Fountains; out of ſome of which there flows a kind of Oyl of the Marrow, (of which mention has been made above) and from others a tough ſlimy Humour (which the ſaid Dr. *Clopton Havers*, the Diſcoverer thereof, calls the *Mucilago*) into the Joints, between the two Cartilages that rub upon each other. And the ſaid Author ſhews by Experience, that it is not without juſt Cauſe that he names them Watry Humours, becauſe he proves, that after the Evaporation of the Water, there does hardly remain the thirtieth Part of that Matter.

Once again, I ſay, let ſuch an unhappy Infidel betake himſelf to ſome Retirement, where he need not be affected with the Shame of Recanting thoſe Erroneous Opinions, which he has ſo long and ſo boldly maintained, and conſider, whether he can believe, ſince this Mucilaginous and Watry Humour is of ſo great Service, that all this *Apparatus* of ſo many Glands as are found in the Joints, and which being compreſſed by the Motion of the Bones, do, like ſqueez'd Spunges, yield this Moiſture; I ſay, whether ſuch a Diſpoſition can be made with-

without any determinate End: And, on the contrary, whether he does not plainly diſcover therein, the Wiſdom and Deſigns of the Creator.

As *firſt*, that theſe Glands (ſome of which being taken out of the Joint of the Elbow, are of the Form repreſented in *Tab.* IX. *Fig.* 6. and others lying by the Knee-pan C, taken out of the Knee at *aaa*, *Fig.* 7. with the Membrane *bbbb*) placed in ſuch a manner, as not to receive any Prejudice by the the preſſing of the Bones; for which purpoſe, the Great Creator has prepared for them a Cavity, which encompaſſes and ſecures them againſt any rubbing or breaking in great Motions and other Caſes. *Secondly*, However in ſuch a manner, that when there are great Inflections and much Work to be done by the Joints, they may be ſoftly compreſſed to make them render their Liquor more freely, of which a greater Quantity is then wanted; and when the Joints are at reſt, theſe Glands may preſerve more of it in them, and not ſhed it in vain. Thoſe who deſire a more exact Account thereof, founded upon ſeveral Experimental Diſcoveries, may have recourſe to the above-mention'd Treatiſe from *pag.* 227. to *p.* 232.

Sect. XVII. *Convictions from the foregoing Obſervations.*

Now how many Convictions of the Wiſdom and Goodneſs of God may be deduced from this Deſcription of the Marrow and Structure of the Glands, may be learned from the aforeſaid Author, *pag.* 238. whoſe Words are as follows; *And here we cannot forbear to obſerve the viſible and palpable Tokens and Footſteps of an Infinite Reaſon, which, as they are deeply engraven upon the Univerſe in general, are yet ſo in a much more particular manner in this wiſe Diſpoſition*

ſition of Motion in Animals. Nor can we ever ſuffici ently admire the Wiſdom and Providence of our Grea Creator, who has communicated to all the Parts of thes Beings, not only ſuch a Compoſition, by which all the ne ceſſary Motions and Operations, requiſite in them, are con veniently produced; but has moreover endowed them with ſuch Advantages and Privileges, whereby they ca both Support themſelves, and Diſcharge their proper Functions in the moſt eaſie manner.

CONTEMPLATION XII.

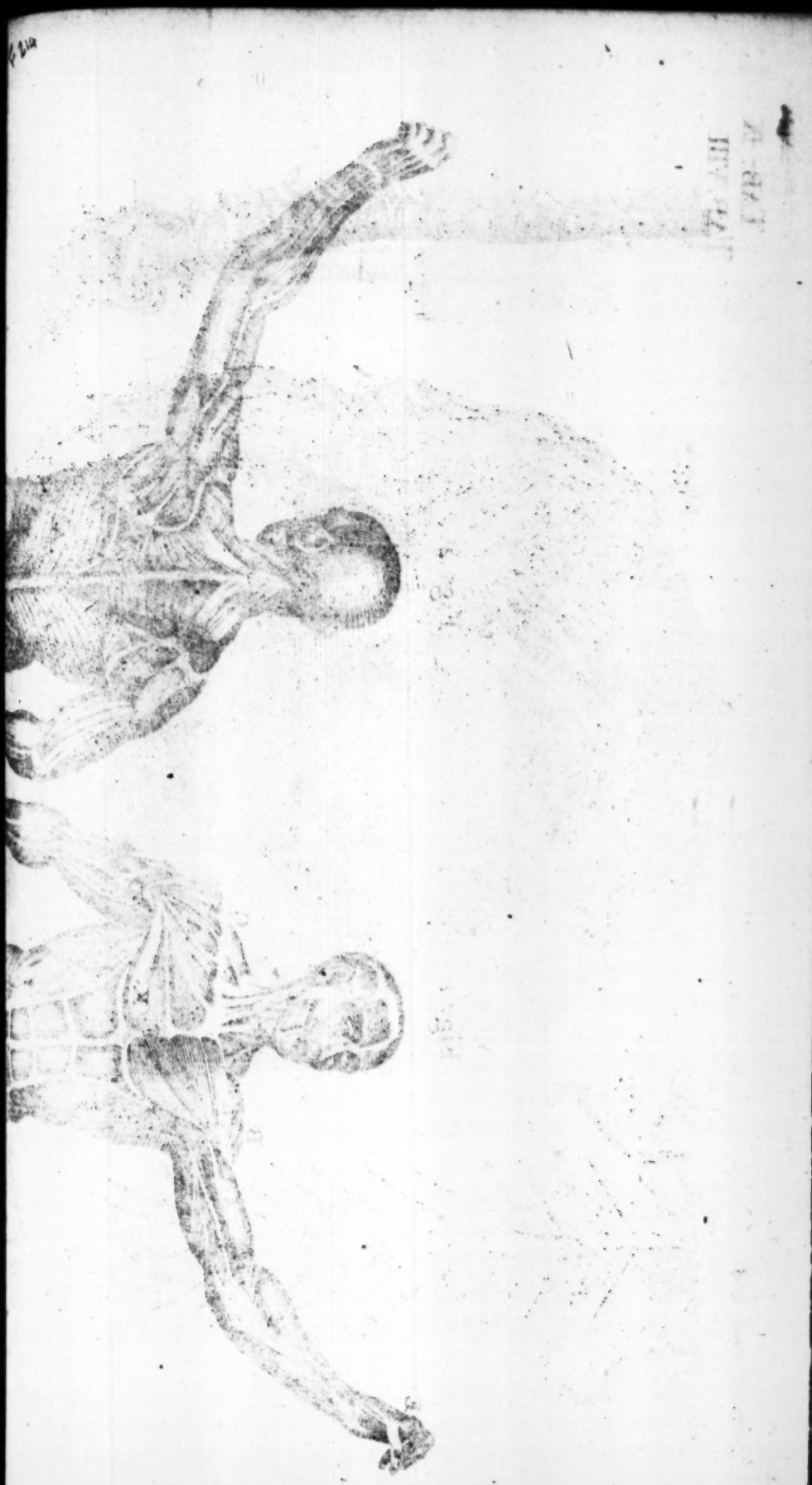
Of the Sight.

SECT. I. *Tranſition to the Sight.*

WE proceed now to the External Senſes, and among them to obſerve in the firſt Place the Inſtruments of Sight; where it muſt needs appear incredible to every one, that ſuch a Number of Particulars and Circumſtances as are requiſite in ſo great a Matter as that of the Sight, ſhould have concurred and met each other in ſo ſmall a Compaſs as the Space that contains the Eye, by mere Chance, or neceſſary Cauſes, without the leaſt View or Intention of the Creator.

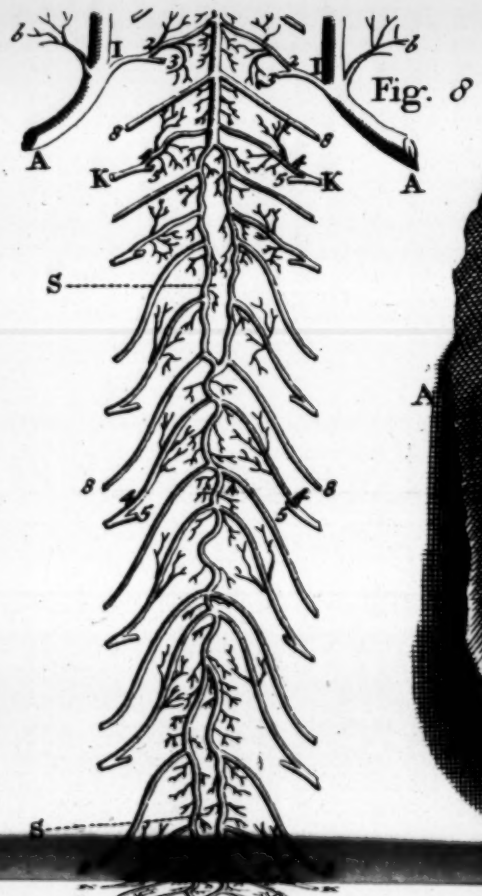
To give therefore a Brief Account of the External Diſpoſition of the Eye: Can it be thought to happen without Deſign?

SECT.



fronting page 214.

TAB. IX



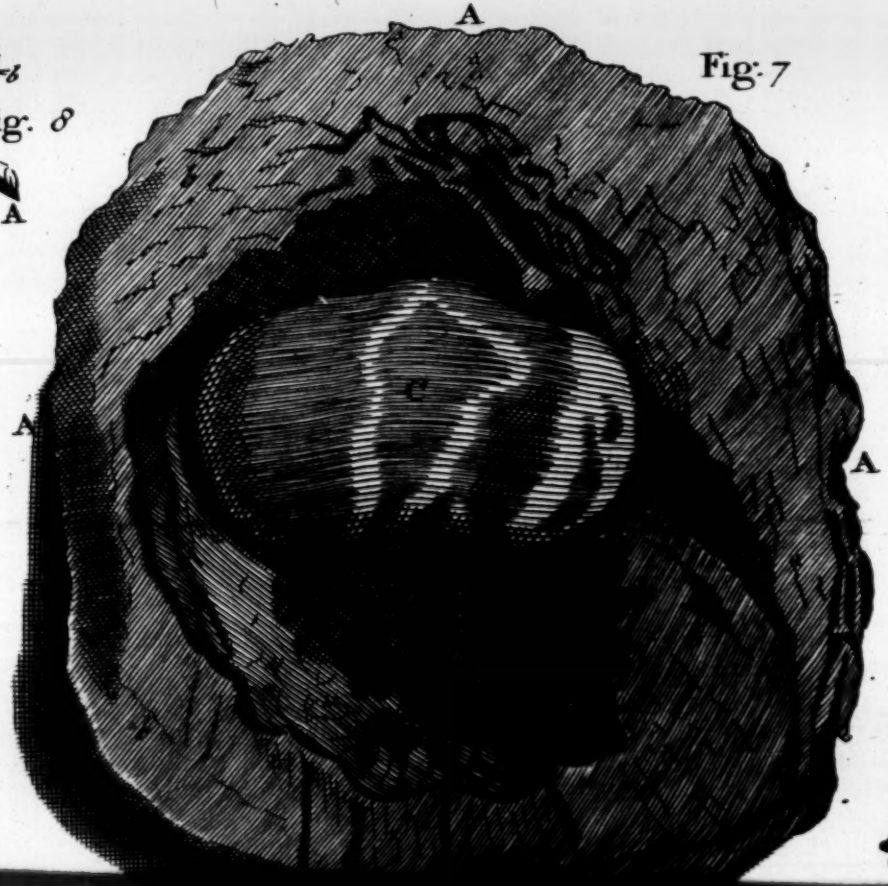






Fig. 6

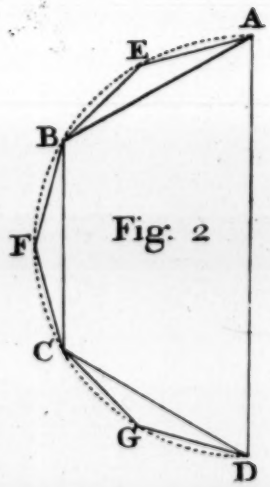


Fig. 2



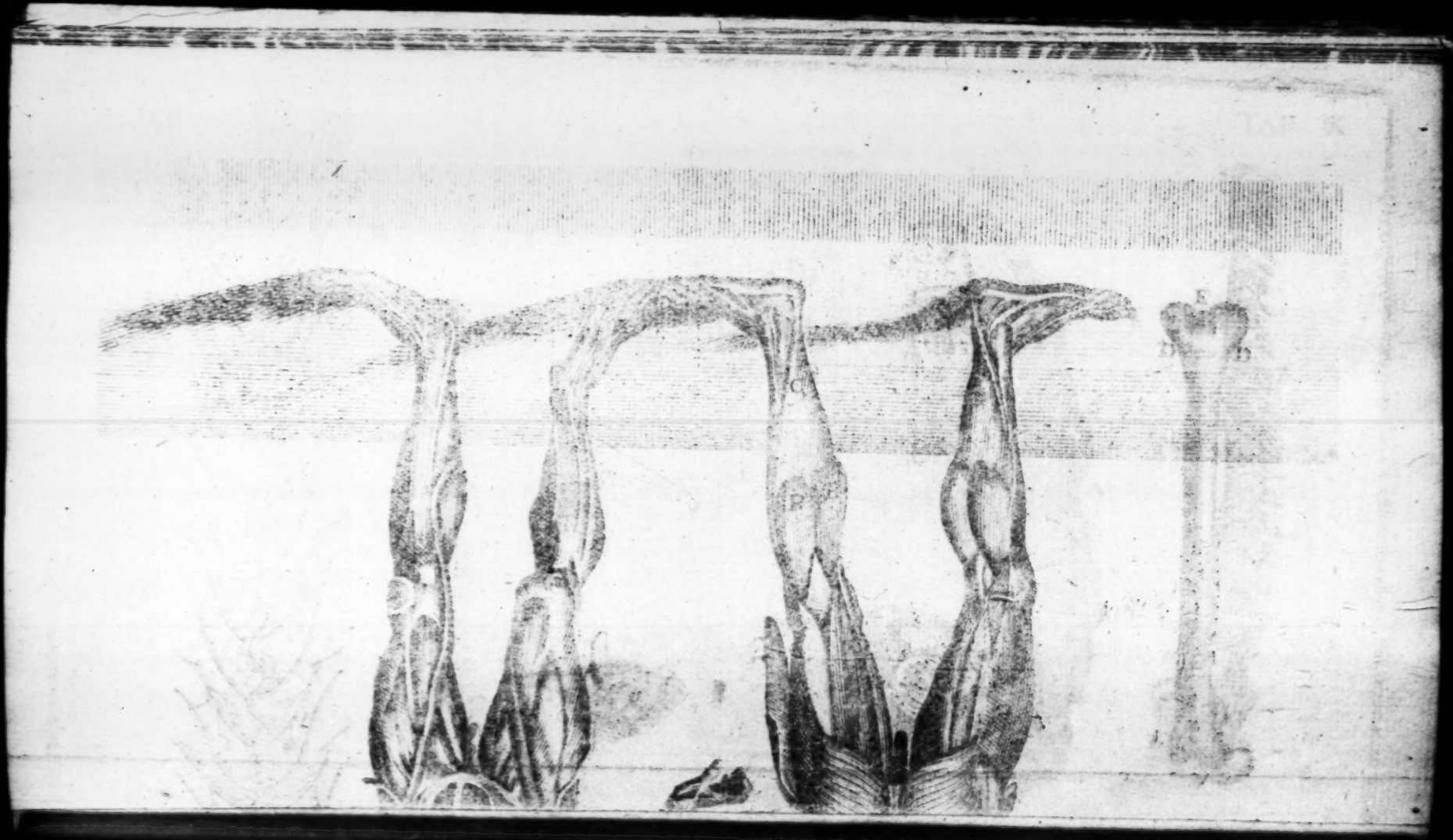
Fig. 4



Fig. 5



Fig. 3


C
B
E
A
D

Sect. II. *The External Structure of the Eye.*

1. That becauſe the Eye is ſo tender as to be hurt by the leaſt Accident whatever, the Eye-lid may, like a Curtain, be drawn over it with unconceivable Swiftneſs upon the approach of any Danger, for the Security thereof; and at the time of Sleep, to hinder the Operation of Light upon it to the breaking of that Reſt which is ſo neceſſary to it. And again, that with the ſame Swiftneſs for the Admiſſion of Light, the Eye-lid can be lifted up and folded together, for which End it is provided with particular Muſcles.

2. To the End, that the Eye-lids may not hang looſe and flabby upon the Eyes, and that their Motion may be the ſwifter, they are provided with a Cartilaginous Bow, which is accurately and nicely adapted to the Convexity of the Eye.

3. That the Eye is encompaſſed on all ſides by Bones, to defend it from all outward Harms: Foraſmuch as by the leaſt preſſure the Figure of it would be changed, and (not to mention the Pain or Smart) the Sight would be greatly diſorder'd. If any body doubts of this, let a Man ſhut one of his Eyes, and preſs the other gently with his Finger, and he will preſently be convicted of this Truth by the different Appearance of viſible Objects.

4. The Structure of the Eyebrows, which are provided with Hair, to prevent the deſcending Sweat of the Forehead from running into the Eyes.

5. To the end that the external Membrane of the Eyes may not be dryed up, and wrinkled by the Air, and ſo not only the Motions of the Eye-lids, but likewiſe the Sight it ſelf obſtructed; that there are Glands placed in one Corner of the Eye, and over it, which by ſeveral little Tubes, ſhed

ſhed a continual Moiſture upon the Eye, to mak it ſmooth, and to ſecure the Membranes from to great a Dryneſs.

6. And to the End, that the Countenance ſhoul not always appear Weeping and cover'd wit Tears, that there are Paſſages contrived, by whic this Humour at the uſual Times can be diſcharge into the Noſtrils. And the ſame Humour in ex traordinary Occaſions, being changed into a floo of Tears, we are then much more ſenſible of th Courſe of them into the Noſtrils.

7. To the end that we may not be obliged con tinually to turn the Head to different Objects there are different Muſcles faſt'ned to the Eye, tha in an inſtant of Time do ſuffice to turn it on al Sides.

8. That no part of this Muſcular Structur ſhould be in vain, the Eye is made in a manne Globular, to turn indifferently in a Cavity adapte to it; the back Part of which is lined wirh Fat to render the Motion ſmoother and quicker.

Sect. III. *The Properties of Light.*

If all this be not ſufficient to convince th moſt obdurate Atheiſt, let him go on to contem plate with us that which follows, and we do no queſtion, but he will be forced to own, that th moſt ſecret Laws of Opticks and Mathematick muſt have been known to him that formed th Eye, before He could have produced ſuch a won derful Machine.

Now it will be neceſſary to ſhew ſome of th Properties of the Light, to ſuch as are unexperien ced in the aforeſaid Sciences; to the End, that the may have a tolerably clear Conception thereo It is therefore well known;

1. Tha

1. That the Light, either of the Sun or of a Candle K, (*Tab.* X. *Fig.* 1.) (to give an Example thereof) falling upon the extream Part or Point of a Needle, render the ſame viſible to an Eye at C C C, *&c.* and R, wherever it be. So that it appears from thence, that the Light diffuſes its Beams, P C, P C, *&c.* Spherically, towards all ſides, or rather like a round Ball; and therefore, that in the whole upper Superficies of the ſaid Ball, as C, C, C, R, *&c.* no Point can be taken, to which ſome Ray, as P C, is not extended, ſuppoſing the Eye at any of the Points, C, C, C, *&c*, or where-ever elſe it is placed in that Sphere.

And that this is each time performed in a ſtrait Line, may be obſerved from hence; that a dark Body S, placed between the Eye at R, and the Point P, in the Right Line P R, hinders the Eye from ſeeing the ſaid Point P.

2. This continual Scattering or Separation of the Rays, P C, P C, *&c.* from each other, is called *Diverging*: And thus we ſee, that all the Rays of Light P C, P C, *&c.* with reſpect to one another, when they proceed from the ſaid Point P, are what the Learned call *Divergent*; as on the contrary, thoſe Rays, for inſtance, that flow from ſeveral Points, C C, *&c.* and by the help of Burning-Glaſſes, or other Optical Methods, are compelled to run into a Point P, are called *Convergent.*

3. It follows from this Divergency (*Tab.* X. *Fig.* 3.) that if from all the Points, as A, N, L, M, B, of the Line A B, (or rather from ſo many as there may be in the whole Line A B) the Rays fall upon another Line S T; that the Rays flowing from all the Points of A B, to each and ſingular Point of the Line S T, cannot be extended without an apparently great Confuſion.

4. Where-

4. Wherefore, in caſe the Rays *Diverging* af this manner, ſhould fall directly upon that Part the Eye where the Sight is to be formed, the Ra proceeding from each Point of the viſible Obj A B, would ſufficiently fill the whole Superfic of the Place, and fall into great Confuſion amo one another, as may be ſeen at S, T, O.

5. Now 'tis a known Law of Opticks, that order to ſee an Object diſtinctly, all the Ra coming from a Point thereof (as from B for ſtance) muſt be collected at the Bottom of the E in a Point *b* (and ſo ſuch as come from A, a other Points of the ſaid Object, in ſo many ot Points again, as *a*, *&c.*) thus forming upon Bottom of the Eye at *a b*, the Picture or Image the Object A B; but inverted, or upſide down

6. Now ſince this cannot happen unleſs Rays, which, according to the Natural Courſe Light, proceed from the Point B *divergently*, wider from each other, are again made *Converg* at the Point *b*, it has pleaſed the Great Creator determine the Motion of Light, with reſpect to *Medium*, or Matter thro' which it paſſes, by oth Laws, by which He brings this great End paſs.

Sect. VI. *Concerning Refraction or Breaking of Rays.*

These Laws are thoſe which in Opticks known by the Name of *Refraction* (that is *breaking*, or rather the bending of the Rays Light) and the Appearances thereof are as follow

1. When Rays paſs from one Medium or Tra ſparent Matter, ſuch as the Air, for inſtance, in another, as Water, Glaſs, Chryſtal and the li whether it be denſer or rarer.

2. Wh

2. When they fall upon the latter with any Obliquity; for if they fall at Right Angles, or Perpendicularly, we find they paſs directly through, and are not broken, or bent at all.

Sect. V. *An Experiment of Rays paſſing from Air into Water.*

If you deſire to ſee this experimentally, ſet a Candle in a dark Room (*Tab.* X. *Fig.* 2.) upon a Table, and an empty white Baſon N K L M, at a little Diſtance from it, in ſuch a manner that the Shadow of the Brim M L, of this Baſon, may extend it ſelf from M to D; when it will appear, that the Ray A M D, which ſeparates the Shadow at D from the Light, is the laſt Ray that falls on the enlighten'd inward Part of the Baſon place N B D.

Then lay a ſhining piece of Money E (for inſtance a Shilling) juſt within the Shade, ſo that the Edge of it may approach very near to D; you muſt take care next to fix that piece of Money in ſuch a manner, that it may not remove from its Place; and laſtly, fill the Baſon up to B C with Water; then you will find that the Shadow will not extend itſelf farther than to F, and the Shilling E will lye out of it in a perfect Light: So that now H F is the laſt Ray that ſeparates the Light from the Shadow.

Now it is plain, that from A to F there can come no direct Ray A F, becauſe it is ſtopt by the Baſon at P.

And yet you ſee the Light proceeding from A to F.

From whence it follows, that as the Ray moved directly in the Air from A to H, inſtead of proceeding ſtrait forwards to D, it is broken and bent, and makes an Angle A H F, at the Superficies of the Water H, and ſo runs from H to F.

And

And thus you have an Example, how a Ray A
paſſing through a thinner Medium, ſuch as A
into a thicker, as Water, is *Refracted* or Broke
and in ſuch a manner as to bend towards the Pe
pendicular Line G H Q, which makes a Rig
Angle upon the Superficies B C, where the di
ferent Mediums of Air and Water are ſeparate
from each other.

SECT. VI. *An Experiment of the Refraction of Ra
paſſing from Water into Air.*

NOw to ſhew the Appearances of a Ray pa
ſing from a denſer or thicker Medium, to a rarer
thinner, as from Water to Air:

Lay the ſaid Shilling E, in an empty Veſſ
N K L M (*Tab.* X. *Fig.* 4.) ſo that one that ſtan
at A S, may be juſt hinder'd by the Brim of th
Veſſel T M, from ſeeing the Money at E: Fo
aſmuch as from E to the Eye A, no direct A E ca
proceed, by reaſon of the Interpoſition of the ſai
Brim M L.

Then fixing the piece of Money E, to the Bo
tom of the Veſſel in ſuch a manner, that it may n
be removed by pouring in the Water, let the
be Water poured into the Veſſel as high as B C
Whereupon he that ſtood at A S, and could n
ſee the Shilling before, will perceive it very clea
ly, as if it was at F.

Now it is plain from all this, that the Mone
really lay at E. and that it could not be ſeen b
any direct Ray E A.

And yet it was clearly ſeen at F.

From whence it follows, that it muſt have bee
ſeen by the Refraction, or bending of the Ra
E H, which, inſtead of running directly to T
makes the Angle E H A, and ſo reaches th
Eye A.

Whic

Which (becauſe we are wont to imagine that we ſee nothing but what lies in a right Line, extended from our Eye to the Object) ſees this piece of Money as if it lay at F.

And to prove that it only happens thus by the aforeſaid Refraction, let another Perſon be placed at I O, whoſe Eye I, is not able to ſee the Money E, while it lies in the empty Veſſel, the Brim of which, N K, intercepts the direct Ray I E; and yet when the Water is poured into it, he will ſee the ſame lying at P, by the help of the Ray E R I, refracted at R: So that the ſaid Money will appear to the Eye A, removed from E to F, but to the Eye I, removed from E to P; and thus two Contradictory Motions will be produced: And in like manner, if there were a whole ring of Spectators about the Veſſel, each one would ſee the Object in a different Place.

From hence it appears, that a Ray, E H, is refracted in paſſing from a denſer Body, as from Water, into a rarer, as Air; and that it does not run directly from H to T, but to A, and ſo is ſomewhat inflected from the Perpendicular Line G H Q.

Sect. VII. *An Experiment ſhewing that Rays falling at Right Angles are not Refracted.*

It is likewiſe plain, that a Ray falling perpendicularly from one Tranſparent Medium to another, ſuffers no Refraction, (as the afore-mention'd Ray did, which came upon it obliquely) if you look upon the aforeſaid piece of Money E, lying in an empty Veſſel, thro' a Narrow and Perpendicular Tube D U, whilſt it lies directly under it; after which, fill the ſaid Veſſel, with Water up to B C, taking care that the Money remain in the ſame Place, and the Tube in the ſaid Poſition,

through which the Money will be ſeen juſt as was before: Whereas, if you look at it through th Tube lying obliquely in the Poſition H T, the Mo ney will not be ſeen at E, as in the empty Veſſe foraſmuch as, in order to ſee it again after th Water is poured in the Tube, muſt be broug down from H T to H A, by reaſon of the R fraction of the Rays: This is what every one ma try, as well as we.

Sect. VIII. *Divergent Rays made Convergent, a forming an inverted Image.*

From theſe two Laws there does now follow a General Rule, which, as appears by innum rable Experiments, is always obſervable in the M tion of the Light, *viz.* that (*Tab.* XI, *Fig.* 1.) t Rays B H, B H, *Diverging* from a Point B, ma by Refraction, be inflected towards each other, a become again *Convergent* in a Point *b*.

1. When they paſs from a rarer Body into denſer, which is Convex and Spherical; an 2. When they fall upon an Object of the like F gure, from a thicker to a thinner Medium.

For inſtance, let K F be a Glaſs poliſh'd on bo ſides, and each ſide of K M F and K N F be Co vex and Spherical: Now when the Ray B comes upon it from the Air, it will not proceed R, but be inflected towards the Perpendicul G H, and take its way according to H P; b in paſſing from the ſaid Glaſs P, into the Air, will not proceed to S, according to H P, but r ceding from the Perpendicular Line P Q, purſ its way to *b*.

And this happening to all the Rays, which f from B upon the Glaſs between H H, they will be united again about the ſame place at *b*, o the middle Ray, B M N *b*, becauſe it falls eve tim

ſame perpendicularly upon the Glaſs, runs directly forward, and without being refracted.

So that in caſe we ſuppoſe (*Tab.* X. *Fig.* 3.) that a S T, a Glaſs is ſo placed, as that the Rays paſſing from A to *a*, from B to *b*, and from the other Points N, L, M, to *n*, *l*, *m*, be united together, they will make at *b a* an inverted Image A B.

Sect. IX. *An Experiment ſhewing the ſame.*

Let thoſe who have a mind to ſee a very eaſie Experiment hereof, place one ſingle Candle in a Chamber at Night, and retiring ſome Diſtance from it, let them cauſe its Light to paſs thro' a Spectacle Glaſs upon a white Paper: Whereupon, having likewiſe ſettled the Diſtance between the Glaſs and the Paper, they will ſee the exact Picture of a Candle inverted upon the ſaid Paper.

That is, at the place *b a*, where all the Rays coming from each of the Points of the Candle, at A B, are collected in ſo many other Points by the two Refractions, which (as in *Tab.* XI. *Fig.* 1.) they ſuffer thro' the Spectacle or Burning-Glaſs, convex on both ſides, and ſo form the above-mention'd Image.

Sect. X. *A Second Experiment in a dark Chamber.*

There is another way of proving the ſame by the famous Experiment of a *dark Chamber*, which is made thus: You muſt make the Chamber as dark as you can, leaving a round Hole in a Window, ſomething ſmaller than the Circumference of a Spectacle Glaſs; then place ſuch a Glaſs exactly before the Hole, taking care that the Light has no other Paſſage into the Room.

Now if you hang a white Cloth or Paper at proper diſtance before the ſaid Glaſs, ſo that the Rays that proceed from every Point of the Object may each of them be collected it its correſponden Point, you will perceive that the Images of ever thing that is without the Chamber will be painte in the moſt perfect manner, upon the ſaid Clot or Paper, according to all its Lineaments and Co lours, eſpecially if the Sun happen to ſhine upo the External Objects, and the Glaſs be in th Shade; as it happens when, for inſtance, the Su is in the South, and the Window in which th Glaſs is, ſtands towards the North, ſo that non of the Sun's Rays come directly upon it.

SECT. XI. *Convictions from the foregoing Obſervations.*

Now ſince it is the Property of Rays that proceed from a Point, to be diverged and ſcattered from each other, and that they muſt be made to converge or be united in a Point again, in orde to Form the Picture of an Object, and thereby to make us ſee it diſtinctly: Can it be conceived that all theſe Laws concerning Light, all this Diſpoſition made in the Eye (how ſmall ſoever it may appear to an Ignorant Perſon) and all the other neceſſary Circumſtances obſerved therein; I ſay can he believe that all theſe things have concurred in ſo little a ſpace, as that wherein the Eye is placed, without any Deſign or Wiſdom of the Creator?

SECT XII. *The Eye is a Dark Chamber.*

Now to repreſent this Mater to every one's entire Satisfaction, and to convince him, that the Images of viſible Objects are really painted upon the

the Bottom of the Eye by the Light, after the ſame manner as in the above-mention'd dark Chamber by a Convex Glaſs; he need only take (thus I find the Experiment to have been made in the Year 1696.) the Eye of a newly killed Ox, while it is warm, (ſee *Tab.* XI. *Fig.* 2. CGRH) after having diveſted it of its Fleſh and Fat, and left nothing remaining but the Membranes and Optick Nerve; then about *b* or *a*, behind in the Eye, let there be a ſmall hole made with the point of a ſharp Knife, in the Membrane in which it is involved; and moreover a little round piece, of about a Fingers breadth, cut out with fine-pointed Sciſſors, leaving it faſten'd only at X, ſo that the Eye may be held by the Part here repreſented at X*t*, and ſo the Orifice CCN directed which way one pleaſes.

Then placing the Flame of one Candle only, lighted for that purpoſe in a dark Room, before the Eye at A B, you ſhall ſee the exact Picture of the ſame inverted very plainly at *ab*, and repreſented burning upſide down.

But that this Experiment may be made as it ought to be, care ſhould be taken not to hurt a very fine and tender Membrane, including the Vitreous Humour behind at *ab*: For whereas you otherwiſe ſee the ſaid Humour it ſelf tranſparent and naked, ſome Light may perhaps appear, but the Image will not be ſo well repreſented.

However, upon ſuch an occaſion, which eaſily happens, one may cover the naked Vitreous Humour behind at *a b*, with a very fine white Paper; by which means you will ſee the exact Form and Motion of the Flame, and alſo the Top of the Candle it ſelf, accurately drawn upon it.

It is more convenient to try the Experiment after this manner, than to place the Eye before the Hole of a dark Chamber, in order to admit there-

by the Images of the External Objects: It is likewiſe performed this way with much leſs trouble.

For one may eaſily ſee this way, 1. That the Eye being brought nearer to the Candle, the Picture is drawn ſenſibly larger; and if removed farther from it, it becomes ſmaller again. 2. That upon moving the Candle towards the Right, or Left Hand, the Picture goes in a direct contrary Motion.

From whence it ſeems probable, that our great Creator makes uſe of theſe Means, to the end, that by increaſing, or leſſening the Images formed in the Eye, we may judge of the Diſtance of Objects by their apparent Greatneſs, or of their Greatneſs by their apparent Diſtance; as He likewiſe makes known to us the Motion of Things that are remote from us, by the Motion of their Images.

For that theſe Images are not formed in the Eye, without making ſome Impreſſion upon the Membranes thereof, ſeems deducible from what a Man feels, who has been any time in the Dark, when he ſuddenly returns into a great Light, and opens his Eyes to look about him.

Sect. XIII. *No Images by Divergent Rays.*

Having thus far ſhewn that our Eye is a real dark Chamber, this Truth does likewiſe occur to us, namely, that ſuch Images of an Object A B, cannot be formed upon the Bottom of the Eye at *a b*, by Rays, which, for inſtance, flow from the Point B, ſo long as they are Divergent, as at B C, B C; but that it is abſolutely neceſſary for that purpoſe, that they ſhould be bent again towards each other by Refraction, in order to be collected into a Point *b*, and there to form the Image.

Sect.

Sect. XIV. *The Tranſparency of the* Tunica Cornea.

Now to repreſent only ſome few of thoſe Circumſtances, which may ſerve for Conviction, without embaraſſing a Reader not well skilled in Anatomy with the different Number of Names given by the Learned to the Membranes of the Eye, of which ſome Anatomiſts reckon only three others 4, 5, 6, 7. yea, 8 and 9, as you may ſee in *Verheyen*; Let us ſuppoſe the little Globular Body, GCHR (*Tab.* XI. *Fig.* 2.) to be the Eye.

Now no Body will conteſt with us,

Firſt, That in caſe all the Membranes which encompaſs the Eye were opaque as well as thoſe that are in the other Parts of the Body; by reaſon of their want of Tranſparency, the Light would be able to get little or no acceſs to the Eye.

Can it be then ſuppoſed to be without Deſign, that notwithſtanding that the whole Eye is encompaſſed round about with an untranſparent Membrane GRH (which ſhews itſelf likewiſe externally, as the *White* of the Eye) yet, at that place where the Light falls upon it, at NCC, there ſhould be found a ſpherical, thin, bright, and very tranſparent Membrane, ſuch as the cleareſt Horn or Glaſs is, in order to afford a Paſſage to the Light; and which is therefore called the *Tunica Cornea*, or Horny Membrane?

Sect. XV. *The Aqueous Humour.*

Secondly, Now in caſe the Rays of Light, BC, BC, coming out of the Air, and from the Point B (for example) and having paſſed thro' this Membrane GNCH, ſhould again meet with the ſame

Air placed in the Cavity of the Eye, G S D T H C G; as it happens in the Cavities of the Ear, where ſuch Air is neceſſary, they would proceed to diverge or ſeparate themſelves from each other, and ſo be unable to form an Image at *b*, which is requiſite in order to ſee the Point B diſtinctly: Will any one again pretend, that it is without Wiſdom and Deſign, that this ſpace G S D T H C G is filled with a Liquor that has all the neceſſary Qualifications in it, *viz.* that it is, *Firſt*, entirely Clear and Tranſparent for the Reception of *Viſion*; *Secondly*, that it is thicker than Air, and about the Subſtance of Water, for which reaſon 'tis called the *Aqueous or Watry Humour*; *Thirdly*, that it is convexly round, as appears by the external Figure of the Eye; from whence it appears plain, that both the Rays, B C, B C, divergent from B, cannot proceed forwards to *g g*; but by the Laws of Refraction, muſt be inflected towards each other, and purſue their way to D D, according to the Lines C D, C D?

Sect. XVI. *Cryſtaline Humour.*

Thirdly, Now if we ſhould ſuppoſe that theſe Rays, according to C D, C D, ſhould again proceed directly to *d d*, we ſhould at the ſame time find, that they would either not at all run into a Point, or at leaſt into ſuch a one as lies very far behind the Eye.

From whence it follows, that there muſt be a new Refraction to inflect them again towards each other, in order to make them meet at *b*, or in a much nearer Point.

Now, in order to make this happen very exactly, another Body, S T D E S, muſt follow; which is, *firſt*, Tranſparent, *ſecondly* Thicker than the Aqueous

Aqueous Humour, and, *thirdly*, in ſome meaſure Convex.

And here again, we find all theſe required Circumſtances to come to paſs in ſuch a manner; for the very opening of an Eye, may convince every Body, that the following Humour STDES, is not only clear, but likewiſe of a thicker Subſtance than the *Aqueous*, for which reaſon 'tis called the *Cryſtaline*, and repreſents rather a ſolid Body than a Fluid, and, which is yet more, it is Convex at SDDT.

Theſe are therefore the Means that hinder the Rays proceeding, as CD, CD, from paſſing on directly to *d d*, and force them, according to the Laws of Refraction, to inflect themſelves a ſecond time towards each other, and to take their way to DE, DE.

Sect. XVII. *The Vitreous Humour.*

Fourthly, Again, if theſe Rays had purſued their Courſe ſtrait forwards to *e e*, they would indeed have met again at the Point *k*, but that would have been too far behind the Eye; and they falling upon the Bottom of the Eye, would have taken up too much room at *m n*; and the ſingle Point of the Object B, would have been here repreſented with a great Superficies, *m n*, which happening thus thro' all the Points of the Object AB, the Rays of ſeveral different Points lying near each other, would have ſtruck the Bottom of the Eye in the ſame place, and ſo have produced a confuſed Image, and therefore confuſed Viſion.

He that does not conceive this eaſily, may repreſent to himſelf, firſt, with a proper Exactneſs by the help of a Convex Glaſs, placed at S T, in a dark Chamber (*Tab.* X. *Fig.* 3.) the Picture *a b*, of an Object AB upon a white Paper *r s*; and then re-

removing the Paper from *r s* to *p g*, or nearer to the Glaſs S T, he will perceive the Confuſion of the Picture, for the Reaſons that have been juſt alledged.

Therefore to prevent this in the Eye (*Tab.* XI. *Fig.* 2.) it was neceſſary, that a ſecond Refraction ſhould be made, whereby the Rays might be collected at the Point *b*, inſtead of the Point *k*.

That this may happen after the beſt and moſt uſeful Manner, the *Cryſtaline Humour* S T, muſt be again Convex at S E T, and that which follows at S G R H T E S, thinner of Matter, and likewiſe tranſparent.

Now all theſe Particulars do occur here again ſince the *Cryſtaline Humour* (as you may obſerve, if you take it out of the Eye) is not only a Convex behind at S E T, but much more ſo than in the fore-part of it S D D T; the whole Cavity alſo of the Eye S G R H T E S, behind the *Cryſtaline* Humour S T, is quite full of a very clear and bright Humour, about the Conſiſtence of melted Glaſs, or, according to others, of the White of an Egg; at leaſt, it is of a thinner Subſtance (which is neceſſary here) than the *Cryſtaline* Humour, and therefore 'tis called the *Vitreous Humour*: This being ſo, they that underſtand the foregoing, muſt likewiſe know that the Rays coming from D E can't paſs directly thro' *e* to *k*; but being again broken at E, muſt be bent towards each other, and purſuing their way according to E *b*, E *b*, muſt be united at *b*.

SECT. XVIII. *How the Image is formed in the Eye, and Convictions from the foregoing Obſervations.*

Fifthly, HAVING thus ſhewn, how the Rays diverging from the Point B of the Object A B, muſt meet at the Bottom of the Eye in a Point *b*; if you ſuppoſe that thoſe Rays which come from every other Point of A B, are likewiſe after the ſame manner collected in a viſible Point of *a b*, you will alſo ſee after what manner the above-mentioned Images are formed by the Light, upon the bottom of the Eye, as it were in a dark Chamber.

Now can any thing more be required by thoſe who ſincerely ſearch after Truth, towards a Proof of the Wiſdom of the Creator, than this wonderful Structure of the Eye, and theſe Inflections of the Rays repeated three times after one another; which, if they had been otherwiſe ſcatter'd or ſeparated, would not only have been unfit in their own Nature, by reaſon of ſuch Divergency, to have formed an exact Image, but even produced a Motion which would have been directly oppoſite to what the *Sight* required?

SECT. XIX. *Several Remarks; Firſt, that the Eye is Black within.*

WE might make innumerable Obſervations upon the wonderful things that are to be found in the Eye; as, 1. That the Eye muſt be dark within, in order to repreſent the Images as ſtrongly as is done in a dark Chamber, and is it not ſo? even ſo far, that its Membranes or Tunicks, are in a great meaſure, and for this very purpoſe, of a Blackiſh Colour: Can ſo neceſſary a Quality as this reſult from Chance?

SECT.

SECT. XX. *The Second Remark; That the Cryſtaline Humour is a Microſcope: And Conviction from thence.*

2. TO the end, that the Images ſhould be nice and accurate, ought there not to be in the Eye a tranſparent Body, Convex on both ſides, and the moſt Convex-part undermoſt? And do not both theſe Qualities occur in the *Cryſtaline* Humour, which has the form of a poliſhed ſpherical Glaſs before and behind, as likewiſe all its Properties?

For, if you take this Humour out of the Eye of a newly killed Beaſt, and hold it before a burning Candle, and a piece of white Paper behind it, you will ſee upon the Paper as exact an Image of the Flame inverted, as if the ſame were projected or made by a Glaſs: Or place the ſame before your Eye, and the Head of a Pin, or any other little thing, cloſe behind it, and if you look thro' it, you will ſee the very ſame Appearances as thro' a real Microſcope, which is likewiſe made Convex on both ſides for the ſame purpoſe.

Did ever any one pretend to ſay, that a good Microſcope had acquired its Figure, its Tranſparency out of a dark or opaque Matter, and its Diſpoſition of being ſo uſeful, without any Deſign of the Perſon that made it? How therefore can it be aſſerted of this Humour, where all thoſe Qualities are found in a more eminent manner? Or could the beſt Artificer in the World, produce ſuch a thing from Bread, Fleſh, Fiſh, and other Food? Can then an unhappy Philoſopher diſcover neither Art nor Knowledge therein, after having obſerved the like Appearances, not once only (which might have happen'd by chance) but in ſo many Millions of Eyes, both of Men and Beaſts?

SECT.

Sect. XXI. *The Third Remark, upon ſeeing at ſeveral Diſtances: An Experiment thereupon.*

3. One may yet farther ſee by the Experiment in a dark Chamber, that the Diſtance of the Object A B (*Tab.* X. *Fig.* 3.) from the Paper *r s*, and from the Glaſs S T, ought to be certain and limited, to form a diſtinct image at *a b*: So that the Paper being held at *p q*, nearer to the Glaſs S T, or at *d e*, farther from the ſaid Glaſs, if the Object A B, and the Glaſs S T, remain in their place, the Image will be very confuſed; becauſe the Rays coming from each of the Points A and B, are not collected in the Point *a* and *b*, but inſtead thereof, take up a great ſpace at *p* and *q*, or *d* and *e*; ſo that thoſe which proceed from different Points muſt thereby be mix'd together and confuſed.

From whence it appears, that no Images can be rightly and truly formed, when the Collection of the Rays that come from A or B, are made at *a* or *b*; the place of Collection *a b*, being either before the Paper, which is then at *d e*, or behind the Paper, when at *p q*.

Again, we likewiſe ſee, if the Object A B is further from the Glaſs S T, or the Glaſs itſelf is rounder, than at the time when a diſtinct Image was formed thro' both of them at *a b*, the exact Image will fall cloſer to the Glaſs, as for inſtance, at *p q*; and therefore the Paper muſt, for this reaſon, be brought forwards from *r s* to *p q*, and nearer to the Glaſs.

The contrary happens, if the Object A B, be brought cloſer to the Glaſs S T, or if the ſaid Glaſs be not ſo Convex, as we at firſt ſuppoſed it; for then the exact Image will not be found, unleſs the

the Paper be removed backwards to *d e*, and the Diſtance thereof from the Glaſs rendered greater.

Now, notwithſtanding that all theſe things come to paſs in our Eyes, yet would our Sight, for all this great *Apparatus*, be of little uſe, and wholly imperfect, with reſpect to the Objects that are near us: So that, for inſtance, one who ſees an Object diſtinctly at the Diſtance of a Yard, would not be able to diſtinguiſh the ſame, either at the Diſtance of half a Yard, or a Yard and half, or any otherwiſe, farther or nearer, unleſs the means above-mention'd were uſed in the Chamber of our Eye, *viz.* either by making the Roundneſs of one of the Humours more or leſs Convex, or the Diſtance between the *Cryſtalline* Humour, and the Bottom of the Eye (which ſupplies the place of the Paper) greater or ſmaller, according as the nearneſs or remoteneſs of the Object requires it.

If this ſhould not be ſufficiently intelligible to one that has not been verſed in Optical Experiments, let him in a dark Chamber make uſe of a flatter or more convex Glaſs; or, to ſpeak in the Language of the Glaſs-Grinders, of younger or older Spectacles, and of a greater or ſmaller Diſtance of the Object; and Experience, after a little attention, will render the thing plain enough to him.

Now, to apply all this to the purpoſe; Can any one, without being aſtoniſh'd at the Wiſdom and Goodneſs of his adorable Creator, obſerve, that not only one of theſe means (which was enough alone) but both together are found in the Eyes? For when an Object is far from the Eye, and therefore (*Tab.* XI. *Fig.* 2.) the Point *a* or *b* (where the Rays proceeding from a Point A or B converge, or are gather'd together) does not reach the Bottom of the Eye X *m*, but falls nearer to the *Cryſtaline* Humour S T; a confuſed Image, as has been ſaid be-

before, would thereby be formed at the Bottom of the Eye, but no diſtinct Viſion; ſo, that to prevent the ſame, it is neceſſary that the Diſtance between the Bottom of the Eye X *m*, and the *Cryſtaline Humour* S T, ſhould be ſmaller; or (if the Diſtance between them remain as it was) one of the Humours of the Eye ſhould be render'd leſs Convex, to cauſe the Image to fall farther, *viz.* at *b*.

Now we find that to bring both theſe things about together, the four Muſcles of the Eye, E F G H (*Tab.* X. *Fig.* 5.) ſeem to be neceſſary to move the ſame (as any one of them is contracted, and ſo made ſhorter than the reſt) upwards and downwards, and to the right and left; and when they act altogether they draw the fore-part of the Eye, as likewiſe the *Cryſtaline* Humour backwards, diminiſhing in ſuch manner the diſtance between it and the Bottom of the Eye; but particularly, it is likewiſe plain, that they make the external Figure of the Eye, which is very Convex and Globular, much flatter, and ſo cauſe the collected Rays to fall more backward, in order to reach the Bottom of the Eye.

Now that the Rays coming from an Object, and falling upon a flatter Glaſs, do paint the Image further backwards than when the Glaſs is more Convex, has been already ſhewn in the Experiment of a dark Chamber.

Now if the Object (*Tab.* XI. *Fig.* 2.) be too near the Eye, and the Collection of the Rays coming from the Point B, does not happen upon *b*, but upon *k*, behind the Bottom of the Eye X *m*; it is plain enough, that to prevent it, the contrary muſt be effected, namely, that the ſpace between the *Cryſtaline* Humour, and the Bottom of the Eye X *m*, ſhould (ſame) the greater; or (the ſpace remaining in the be made *Aqueous* Humour of the Eye at M *c c* ſomewhat rounder.

For

For that a rounder Glaſs forms the Image ſhorter and nearer to itſelf, may be experimentally proved with great eaſe in a dark Chamber.

Now to perform both theſe Operations at the ſame time, the Anatomiſts produce two Muſcles at INKM (*Tab.* X. *Fig.* 5.) which they call oblique Muſcles; and which, when contracted, do each of them draw the Eye on its ſide, but when they work together, they draw the Eye as it were with a Girting Rope, and ſwelling up, preſs it on all ſides; by which means the *Aqueous* Humour being made protuberant, the Eye becomes rounder at NCC (*Tab.* XI. *Fig.* 2.) and the *Vitreous* Humour being preſſed backwards, the Diſtance between the Bottom of the Eye and the *Cryſtaline* Humour is render'd greater.

I know very well, that ſome Learned Gentlemen do not think that the peculiar Uſe of theſe Muſcles, for this purpoſe, is yet fully aſcertained, till it has been farther proved; but we ſhall not let ourſelves into this Diſpute at preſent, no more than we ſhall enquire whether thoſe only have hit upon the Truth, who maintain, that the Fibres GS and HT (which the Anatomiſts call *Proceſſus Ciliares*) have a quality of cauſing the *Cryſtaline* Humour it ſelf (when ever it is neceſſary) either to change its Figure, that is to ſay, rendering it more or leſs Convex; or of bringing it nearer and removing it farther from the Bottom of the Eye.

However, the one or the other of the Operations above-mentioned, ſeems to be experimentally felt in the Uneaſineſs, or ſometimes even in the Pain, which the Eye ſuffers, when we uſe any Force to ſee an Object that is far from the Eye diſtinctly, or to read a Writing a little too near.

But

But this is inconteſtably true, that the Eye does ſomething in the viewing of things that are placed at ſeveral Diſtances from it, without any Concurrence or Knowledge on our part, which the greateſt Mathematicians have not yet been able to bring about by their Inſtruments of ſeeing; the Diſpoſition of which, as the diſtance of an Object is notoriouſly greater or ſmaller, muſt likewiſe be alter'd. And this is ſufficient to convince us (tho' we know nothing of the manner how it happens) that there is a GOD, by whom we are made, and who had a wiſe End and Deſign in forming the Eye, as it here appears.

SECT. XXII. *The Fourth Remark, upon the Opening and Shutting the Black of the Eye or Pupil, with an Experiment proving the ſame.*

Fourthly, IF this great and wonderful Structure of the Eye, by which we are enabled to ſee ſo eaſily and diſtinctly, at ſo many and ſuch different Diſtances, be not yet ſufficient to convince a Sceptical Enquirer of the Wiſdom of his Creator, let him proceed farther, and in the laſt place (ſince, if we take notice of every thing concerning the Eye, that alone would require a whole Book) to contemplate with us that which follows:

Firſt, That if the Hole in a dark Chamber be made ſo ſmall as to admit but too few of the Rays, the external Images would be repreſented imperfectly without the neceſſary Force and Livelineſs.

Secondly, If the Hole be ſo great as to admit of the Entrance of too much Light, the Images would appear yet more weak and imperfect for other Reaſons. So that there is an exact Proportion required for that Hole or Space, thro' which the Rays are to be admitted, to the end, that every

thing may have its proper Energy; and that the number of the Rays be neither too great nor too ſmall: And how much trouble the finding the juſt Proportion of ſuch Holes or Openings occaſions to thoſe who make Teleſcopes, Microſcopes, and other Inſtruments for ſeeing, is but too well known by thoſe that have had the trial of it.

The ſame thing happens to the Eye, as being a *dark Chamber*; and it is eaſie to diſcover experimentally, that too few Rays render the Sight of an Object weak, if you make a Hole with a Pin in a white Paper, which Hole ſhall be much ſmaller than the little black Circle of the Eye, called in *Latin*, the *Pupilla*; and thro' which the Rays of the Object are admitted into the Eye.

Now when you look thro' the ſaid little Hole (eſpecially in a place where the Light is not too ſtrong) upon a piece of Marbled Paper, in which there are a great many Colours, it is well known that if it be held cloſe to the Eye, there can come no Rays from it but thro' the aforeſaid little Hole; and that therefore the number of them is much fewer than if they were immediately received in a greater Opening of the *Pupilla* without this Hole: But we ſhall likewiſe find at the ſame time, that the Colours of the Marble Paper will ſhew themſelves much fainter and darker thro' the little Hole, than they would directly to the naked Eye.

Now in caſe this Pupil, being too large, ſhould admit too many Rays, as it does when one paſſes ſuddenly from a very dark Place into a clear and ſtrong Light; we find likewiſe, that upon this account, the Action of *Seeing* becomes very troubleſome.

Now to produce again a Proof of GOD's wonderful Wiſdom and Mercy from this laſt Inſtance, Could any Body reaſonably ſuppoſe, that what is done

done herein, with ſo much trouble by the Artificers in their Optical Inſtruments, is performed by the Eye of itſelf, and without the Direction of the great Creator, and even without the Knowledge of the Man himſelf in whom it happens? And moreover, after ſuch a manner as infinitely exceeds the fineſt Machine that Human Art has ever yet brought to the higheſt degree of Perfection?

Thus we ſee that the Paſſage F F (*Tab.* XI. *Fig.*2.) thro' which the Rays of Light go, or rather that black little Circle in the Membrane (according to which our Eyes are denominated Black, Grey, or any other Colour) commonly called, the *Black or Apple of the Eye*, becomes in a healthy Man ſmaller in a great Light, and immediately greater in a ſmall Light; in order to admit more or fewer Rays, as the Circumſtances of things require.

I know very well, that no Body who has never ſeen this will readily believe it; but in order to convince him thereof experimentally, let him be brought into the Sun-ſhine, or any other ſtrong Light, or place him in a Chamber directly oppoſite to the Light of the Windows in a very bright Day; where, if you obſerve the Pupil of the Eye, you will find it to be very ſmall in ſuch a great Light, to the end, that the Eye may not be hurt by the ſtrength thereof; then ſet him in a dark Corner of a Chamber, and turn his Face from the Light; when you will preſently perceive the *Pupil* to become ſenſibly larger, in order to admit a greater number of Rays; inſomuch, that after theſe Experiments, no Body can doubt of what has been here ſaid.

Is not the great Goodneſs of God particularly remarkable herein, that all theſe things come to paſs in our Eye, without our being conſcious thereof, to the end, that our Attention may not be diverted from whatever we are then contemplating?

ing? Which however would have always happen'd if we had been obliged to have attended to every Occaſion of adapting the *Pupil* to the Degrees of Light.

SECT. XXIII. *Convictions from the foregoing Obſervations.*

Now whoſoever is a reaſonable Perſon, and does plainly comprehend all that we have been ſaying about the Eye, ought he not to be aſtoniſh'd that as there was a *Lucretius* among the Ancients ſo there are likewiſe in our Age Men that pretend to be Philoſophers and Enquirers after Truth, and yet will not allow that the Maker of all theſe things, which contribute towards the forming of a good Sight, had any Wiſe Purpoſes or Deſigns in forming the ſame?

And yet, if any of theſe Men ſhould ſee a good *Microſcope*, or a Set of Magnifying-Glaſſes, or a well-made *Teleſcope*, or a *dark Chamber*, with all its *Apparatus*, none of 'em will dare to ſay, that thoſe things were framed by Chance. And can they then affirm it of the *Eye*, the Structure of which they muſt own, whether they will or no, to be unſpeakably finer than all the Inſtruments for Sight that ever were invented by the Art of Men?

Ask then the greateſt Mathematician, the moſt skilful Man in Optics, or Mechanics, whether he can be able to make a dark Chamber, that can be turned which way one will as readily and eaſily as the Eye; which, if turned towards remote Objects, can ſhorten itſelf and flatten its Glaſs, and upon the nearer approach of an Object, can make itſelf longer and its Glaſs rounder, without ſtanding in need of any other Aſſiſtance; yea (let the Cauſe thereof be what it will,

that

that can adapt itſelf to the various Diſtances of Objects, and accordingly form at every time a different Object; that when the Light is too ſmall, can dilate its Hole or Opening; and when the Light is too ſtrong, can again contract the ſame, without the concurrence of any thing elſe beſides the Diſpoſition and Laws belonging to it?

Sect. XXIV. *The Sun neceſſary to Sight: And Convictions from all the foregoing Obſervations.*

Now to ſay no more, Have we no reaſon to acknowledge the Goodneſs and Power of the Great Creator, who has made ſuch unſpeakably great Bodies as the *Sun* is (not to mention the *Moon* and *Stars*) ſubſervient to theſe Purpoſes? who, to compleat this Deſign, and to make the Eye uſeful, has cauſed the Light to flow from thence, in ſo vaſt a Quantity, as to be able to fill the immeaſurable Space between us and the Firmament, even as far as to the Planet *Saturn* itſelf, which is ſuppoſed, and not without reaſon, to be enlighten'd by the *Sun*; who derives the Light itſelf with ſo unconceivable a Swiftneſs down to our Eyes, that they may be continually ſupplied therewith, inſomuch, that if ſuch Swiftneſs, and all the other Properties of Light, of which we have been ſpeaking (and of which we ſhall treat hereafter more particularly) were not demonſtrable, they might juſtly be doubted of by every one.

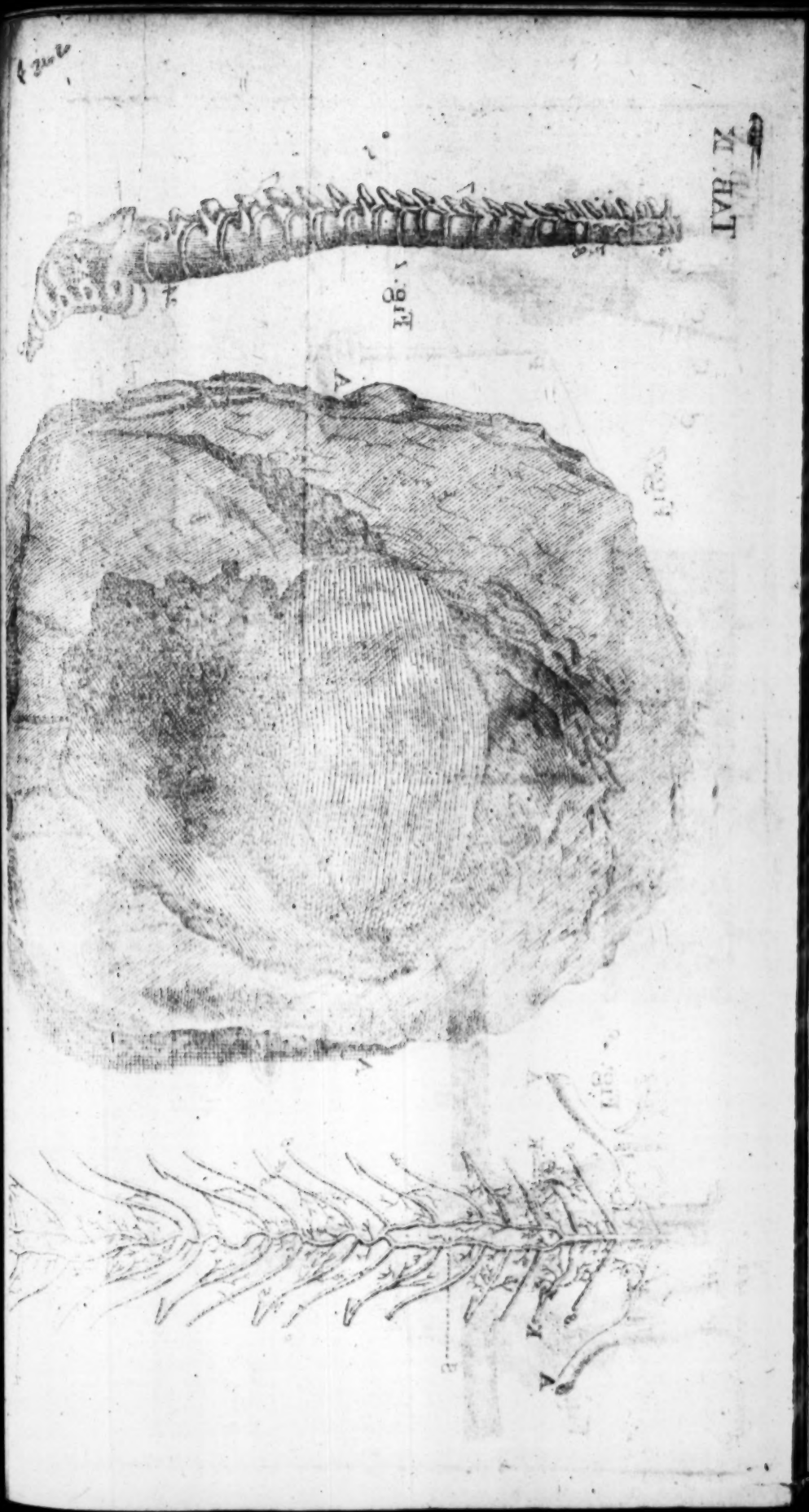
Can any Body contemplate all theſe great Things that are neceſſary to make us *ſee*, and that co-operate as well within as without the *Eye*, and not think himſelf in the leaſt obliged to Him that has beſtowed ſuch Bleſſings on him? Who warns him thereby timely and from afar, of ſo many things, whether they be Advantageous or Prejudicial to him; who

grants him the Pleaſure of being able to View and Contemplate ſo many agreeable Colours in Fields, Trees, Flowers and the like; and to ſum up all in one Word, who has vouchſafed him the Faculty OF SEEING; and who has made our Eye after a moſt aſtoniſhing manner, a perfect Stage or Theatre, from whence we may view all his Wonders, how ſmall ſoever it be in Compariſon of the Terreſtrial and Celeſtial Bodies; making of his Light an admirable Pencil, for ſo the Mathematicians call the Compoſition of Rays repreſented in *Tab.* X. *Fig.* 3. by B S T *b*; as alſo in *Tab.* XI *Fig.* 2. by B, C C, D D, E E, *b*; which proceeding from a Point as B, are after due Refractions united again in another Point *b*, by which means all his great and glorious Works of Sun, Moon, Stars, Earth, Sea, Mountains, as alſo Trees, Flowers, Men, Beaſts, and whatever elſe is corporeal and viſible are painted after an unimitable manner, in their true Colours and Lineaments upon the Bottom of the Eye?

Can it ſtill be thought to be the reſult of mere Chance (ſince the Light, whilſt it ſcatters and ſpreads its Rays aſſunder, is in itſelf improper to produce a clear and diſtinct Sight) that nevertheleſs, and only to render Men and other Living Creatures happy, Laws of *Refraction* were preſcribed to this Light, by which its Rays were turned from *Divergent* into *Convergent*; that is, from ſcatter'd to united? Or that it is without Wiſdom that this great and unfaſhionable Sea of Light, in all its moſt minute Particles, has ſubmitted to theſe Laws, without departing one Tittle from them? Of which more hereafter.

Can any Body think it to be without a wiſe Deſign, that all the Limbs of a Humane Creature from his Childhood to his Manhood, grow continually and proportionab'y greater, but the *Cry-*

ſtalli-



fronting page 142.

TAB. X

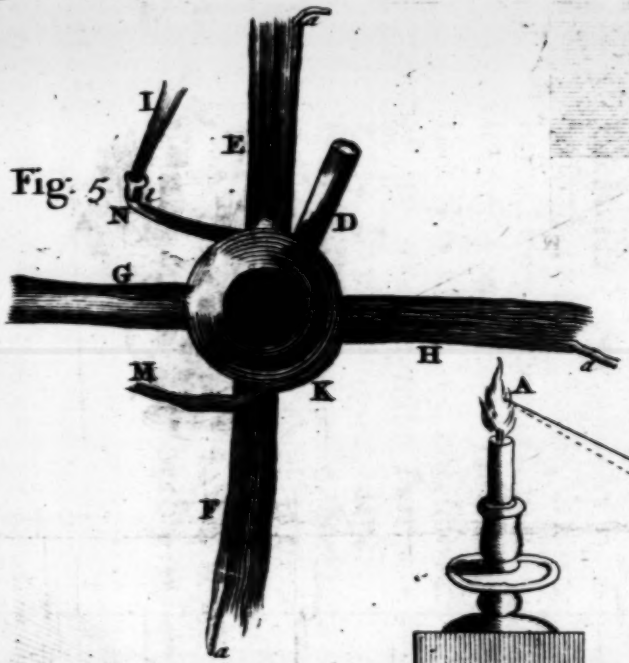


Fig. 5

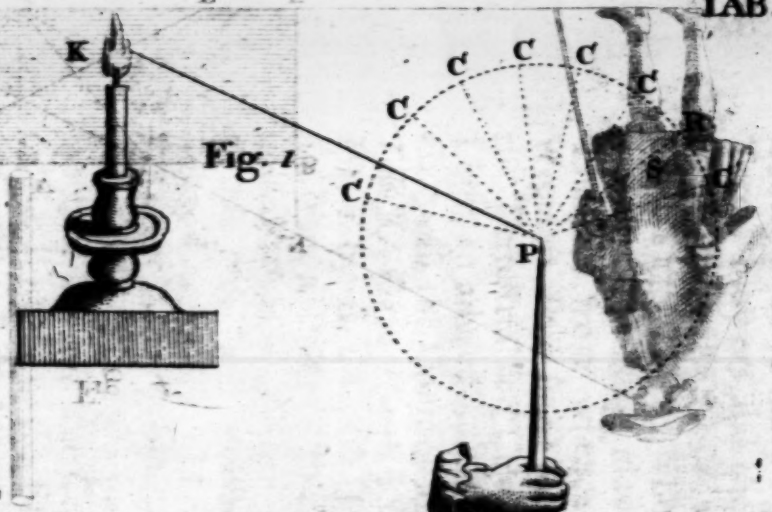


Fig. 1

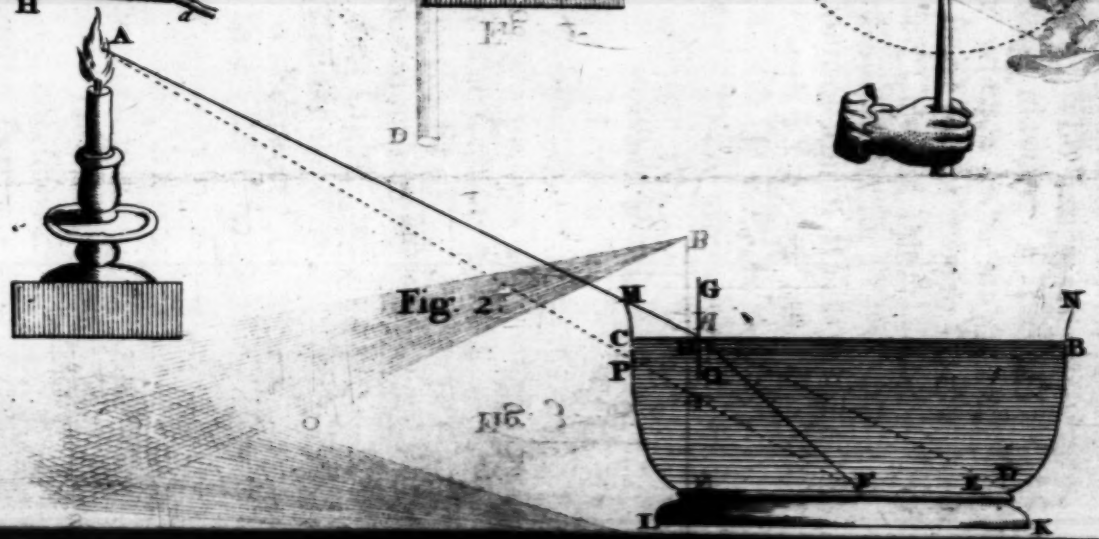


Fig. 2

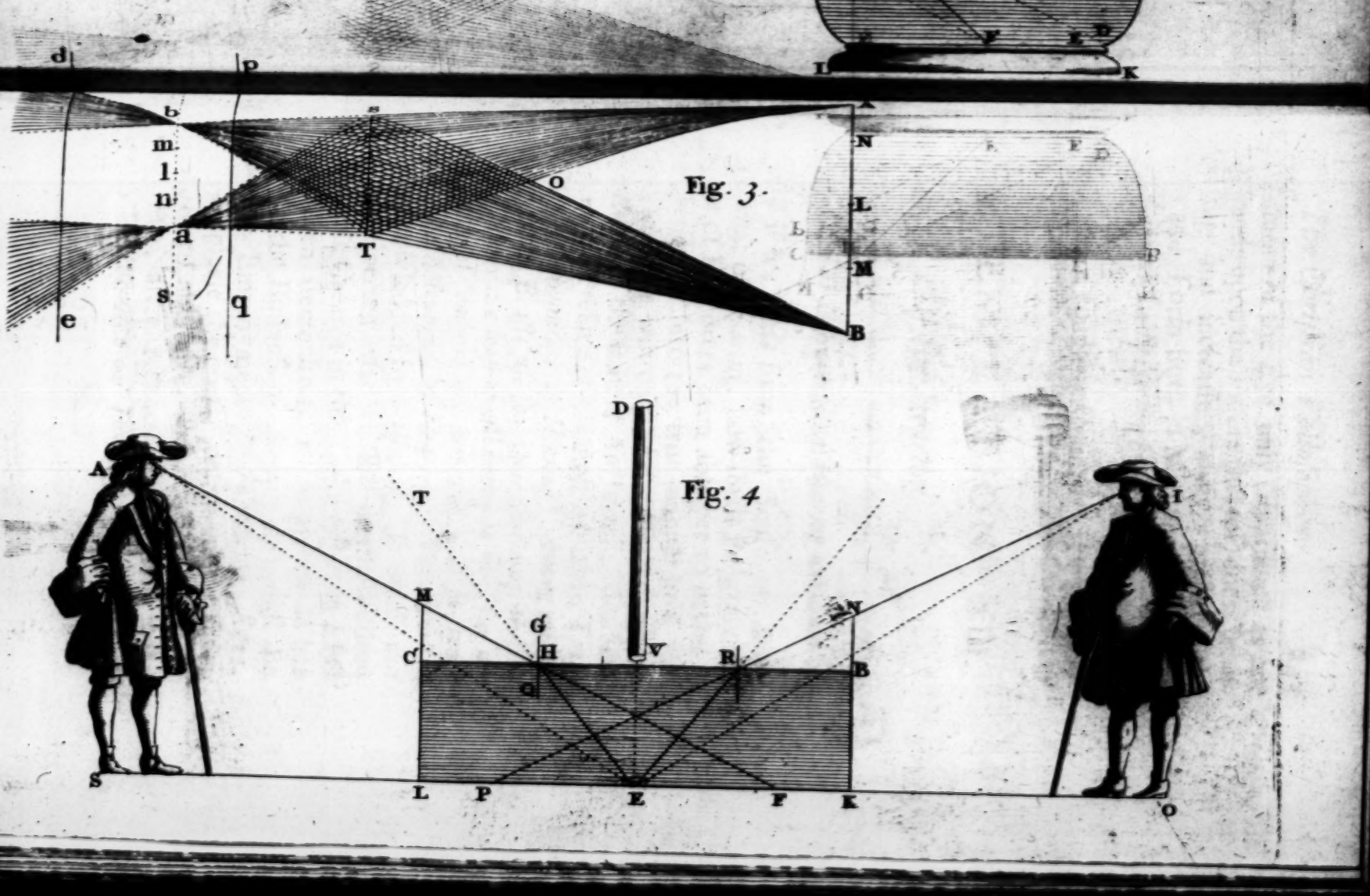


Fig. 3.

Fig. 4

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

ſtalline Humour of the Eye only (foraſmuch as our Sight depends upon the Figure thereof) does, without growing and increaſing, always preſerve the ſame Size and Form both in Men and Children? See this Remark in *Bergerus*, *pag.* 407.

CONTEMPLATION XIII.

Of the Hearing.

SECT. I. *The Inſtruments of Hearing unknown.*

NOW if we paſs from the Senſe of *Seeing* to that of *Hearing*, how ſmall Progreſs has the Labour of Enquirers been able yet to make, in order to penetrate into the true manner how this laſt is perform'd, it will only be neceſſary to quote the Expreſſions of the famous Anatomiſt, Monſieur *du Verney*, in the Preface of his moſt laudable Treatiſe about *the Inſtruments of Hearing*: *Among all the Inſtruments which Beaſts uſe for their Service, thoſe of the external Senſes are leaſt of all known to us; but nevertheleſs, none of 'em all are attended with ſo much Obſcurity as the Inſtruments of Hearing.* The ſame is likewiſe acknowledged by *Valſalva*. It muſt not therefore be expected, that we ſhall ſet the Wiſdom of the adorable Creator in this Caſe, either in a full Light, or even demonſtrate it ſo plainly as has been done in the Buſineſs of *Seeing*; this muſt be the agreeable Employment of following Ages, when it ſhall pleaſe the great Creator to give them a Clew to this Labyrinth, and further, to bleſs their Enquiries, after repeated Diſcoveries, concerning the Inſtruments of *Hearing*, of *Sound*, and of *Muſick*.

Sect. II. *But they are ſtill ſufficient to prove the Wiſdom of GOD.*

However, to ſhew that notwithſtanding Humane Wiſdom is not yet capable of finding out the right Uſes of all thoſe Inſtruments that belong to the Senſe of *Hearing*; yet the Structure thereof, as far as it has been hitherto diſcover'd, is ſufficient to prove the wonderful Wiſdom of the Creator to an Enquirer after Truth; and ſo convince an Atheiſt too, if he be not more Obſtinate than Ignorant: Since we have not here undertaken to deſcribe a compleat Anatomy of theſe Parts, it will not be uſeleſs to transfer the following Figures from the Tables of *Valſalva*, which repreſent to the Life the Structure of the Inſtruments that ſerve for *Hearing* with reſpect to each other; ſo that from them, with ſome others which we ſhall add for greater Clearneſs, the Reader will be able to form a rough Conception thereof.

Sect. III. *The External Structure of the Ear.*

Let us then begin from the External Structure of the Ear, which every one may ſee in other Treatiſes.

Can any one ſuppoſe that it is Accidental, and without Deſign, that two Ears are placed upon the Head? which ſerve to receive Sounds by the Mediation of the Air; as may be ſeen in ſeveral Beaſts, who, as the Sound comes from certain Places, are wont to turn the Cavity of their Ears that way; as likewiſe in Men, who, when one of their Ears fail them, endeavour to repair that Defect, by holding the Hollow of their Hand behind it: And can one ſee, without acknowledging a Deſign of the Creator, that when the Sonorife-

rous

rious Air is come into the Cavity of the External Part of the Ear, it meets with a moveable Protuberancy at the Mouth of the Auditory Tube (called by the Anatomiſts the *Fragus*) by which the Air is hinder'd from avoiding this Entrance of the ſaid Tube, and compelled to run into its Oriſice or Mouth.

Now foraſmuch as the Ear, if it were compoſed only of a ſoft and flabby Matter, like the Membranes, would hang down over the Oriſice of the Auditory Tube, and hinder Hearing; or if it were of a harder and bony Subſtance, would occaſion Inconveniencies in our lying down and otherwiſe: How manifeſt is the Wiſdom of the Creator, who has compoſed the ſaid whole Ear of Membranes ſupported with Cartilages? by which means it is endowed with an Elaſtick Faculty (as you may obſerve when you bend the Ear with your Hand, and let it go again) to the end, that it may redreſs itſelf, and return to its former State in all Accidents; and perhaps too, as ſome think, to promote the Tremulous Motion of the Sonorous Air. This is certain, that the Auditory Tube is at the beginning of it, made of the ſame Cartilaginous Subſtance with the Ear, but farther in it, conſiſts of Bone only, as is ſufficiently known to the Anatomiſts.

Sect. IV. *The Auditory Tube, and the Membrane called the* Tympanum *or Drum.*

To ſay ſomething more of this, let (*Tab.* XI. *Fig.* 3.) LL be the Circumference of the extreme Part of the Ear, and K the circular Cavity that appears therein (called the *Concha* or Shell) and which can be ſeen outwardly; and in which is alſo the Oriſice of a Tube A C, which extending itſelf internally in the Head, is called the *Auditory Tube*.

This

This conſiſting of a Cartilage about that Part of the Ear marked A, and afterwards as far as C, of a Bone only, is cloathed on the inſide with a Skin or Membrane, which in this Figure is repreſented alone without the Bone and Cartilage; and at the End of it F, it is ſhut up by a Membrane which is round, dry, thin, ſolid and tranſparent, and which is called the *Drum* of the *Ear*. But ſome are of Opinion, that there is a ſmall Orifice in this Membrane, which ſeems to be in ſome meaſure likely, becauſe ſuch as take Tobacco have been obſerved to convey the Smoak thereof from the Mouth thro' the Ears.

And thus we ſee how the Sonoriferous Air, admitted into that Part of the Ear L L, and collected in the *Concha* K, enters into the Auditory Tube, and paſſing from A to C, ſtrikes againſt the Membrane F, and puts it into Motion.

SECT. V. *The Cavity called the Drum, the Bones of the Ear, and the* Chorda *or Little-String.*

BEHIND the Membrane of the Drum, more inwardly in the Head, there is a certain Cavity, which the Anatomiſts call the *Tympanum* or Drum, upon which you muſt ſuppoſe that this Membrane is extended much after the ſame manner as the Skin of a Kettle Drum.

In this Cavity Anatomiſts obſerve ſeveral wonderful Things, ſome of which are contained within it, and others in its Circumference: The firſt things within it, are the four little Bones of the Ear, and a ſmall Nerve, called the *Chorda Tympani*, or String of the Drum; to ſay nothing here of the Muſcles, and other Singularities that occur therein. The other things conſiſt moſtly in the Openings that appear in the Bone of the Drums Circumference, whereby the Cavity thereof has a Communication

nication with other Cavities, either with, or without the intervention of Membranes.

Theſe Auditory Bones (*Tab.* XI. *Fig* 4.) are found to be four in number, C S is the *Hammer*, B P the *Anvil*, P V the *Stirrup*; and between the Anvil and Stirrup there lies at P, a ſmall roundiſh Bone, which makes the fourth in Number.

Between two of theſe Bones (*Tab.* XI. *Fig.* 3.) there is a little Branch of a Nerve E O, or *String* of the *Drum.*

Sect. VI. *The Motion of thoſe Inſtruments.*

Now if we ſuppoſe that the Tail S, of the Hammer C S, is faſten'd to the Membrane of the Drum which lies there under it, we may obſerve at the ſame time, that this Membrane being moved by the Sound, that paſſing into the Auditory Tube A C, ſtrikes upon it, will likewiſe move the Hammer C S, as that will do the Anvil B P; by which laſt, and by the fourth little Bone P (*Tab.* XI. *Fig.* 4.) the Stirrup V P, will likewiſe be moved: And ſo the little String or Nerve E O (*Tab.* XI. *Fig.* 3. when the Hammer C S, and the Anvil B P, are ſtirred by the Membrane of the Drum,) will always follow the Motions thereof: So that from hence it appears, that the Motion of the Membrane of the Drum, communicates itſelf to all theſe little Bones, and to the *Chorda Tympani.*

Sect. VII. *The Openings in the Circumference of the Cavity of the Drum.*

To have a true Notion of the Circumference of this Cavity, which an unskilful Perſon muſt take care to diſtinguiſh from the Membrane of the Drum, ſince *Valſalva* has not drawn it entirely, but only the Openings that are therein; you muſt ſuppoſe

poſe it to be a Cavity that comes behind the Membrane of the Drum (*Tab.* XI. *Fig.* 3.) and encompaſſes theſe little Bones: Or you may conſult hereupon the Figures thereof in Monſieur *du Verney*, which, if we ſhould here reckon them up, would require too many Explanations.

In this Circumference of the Cavity of the Drum Anatomiſts do then find;

1. The Opening of the inmoſt Part of the Auditory Tube A C (*Tab.* XI. *Fig.* 3.) which is ſhut up by the Drum Membrane F.

2. The opening H, of the Tube H G I, called the Trumpet of *Euſtachius*, which terminates at I, in the furthermoſt Part of the Roof of the Mouth; ſo that the Air paſſing thro' it from the Mouth, from I to H, can enter into the Cavity of the Drum, and be again diſcharged the ſame way. The Wiſdom of the Creator does wonderfully appear in making this Orifice in the Roof of the Mouth after ſuch a manner, that the freſh Air drawn in by the Noſtrils, is directed in its way thither by a little Protuberancy; and when it returns from the Lungs, charged with Vapours, it paſſes by this Orifice more eaſily than it can enter into it.

Valſalva ſhews by Experience, that this being ſtopt, the Ear on the ſame ſide is immediately Deaf; but when open'd, hears again.

And this, according to all Appearances, is that Paſſage for Sounds, by the help of which, Men that have been entirely Deaf, have ſometimes been able to tune a Muſical Inſtrument, and others have been found to hear by the Mouth; for which purpoſe, a little Stick, held between the Teeth, or ſet againſt it with one End, has oftentimes done great Service, whilſt the other End, reſting upon the Inſtrument, ſerves for a Paſſage to the Tremulous Motion of the Air. The Paſſage of the Tobacco Smoak from the Mouth to the Ear, of which

we

we have already ſpoken, may perhaps be traced after the ſame manner.

3. The little Part of the Bone D, is the ſide of a Bay or Creek, which makes the Cavity of the Drum larger, and is continued to the Cavity of another Bone, called the *Apophyſis Mammillaris*, or *Maſtoides*. In the firſt Entrance of this Bay, the ſharp End of the Anvil reſts, as may be ſeen at D.

4. In the upper Part of this Bay, *Valſalva* has diſcover'd ſeveral Holes, by which there is a Communication between the Cavity of the Drum and that of the Skull itſelf.

5. There are yet two Openings in the Circumference of the Drum; the firſt of 'em are called the *Oval Window* (*Tab.* XI. *Fig.* 5.) o, and this Opening is ſtopt by the *Stirrup*.

6. The other is called the *Round Window* p; which is ſhut by a Membrane like that of the Drum. You muſt ſuppoſe, that both theſe Openings, o and p, are here in one Bone, which is a part of the Circumference of the Drum's Cavity; and that all theſe Threads and little Tubes 1, 2, 3, 4, are quite out of the Drums Cavity, which we have put out of the way, that they mayn't hinder the Sight of 'em.

Sect. VIII. *The Labyrinth or Maze of the Ear.*

These two Oval and Round Windows open the way for Enquirers to the laſt and moſt inmoſt Cavity of the Ear; which, by reaſon of its wonderful Figure, is called the *Labyrinth*. Being ſtrip'd of the Bones that lie about it, it ſhews itſelf as deſcribed in the Table, only the End or Point of this Snails Courſe 4, muſt be ſhewn ſomewhat riſing from the Paper, and not lying in the ſame Place with all its Windings, juſt as you ſee in the Snails themſelves, their Point to be a little elevated. I

add

add this Remark, becauſe mention'd by *Valſalva*. You may ſee it better delineated in *Tab.* XII. *Fig.* 1 but with the ſame Fault as *Tab.* XI. *Fig.* 6. and the better to ſhew all the Parts, the Labyrinths are placed in a different Situation.

The Parts of this laſt Cavity (the Labyrinth) are commonly divided into three; namely, Firſt three Semi-circular Veſſels, 1, 2, 3. Secondly the *Cochlea* or Snail 4; and Thirdly, a Cavity called the *Veſtibulum* or Porch, which lies between the two, and which, for greater clearneſs, is repreſented open (*Tab.* XI. *Fig.* 6.) To ſay a word or two of each.

We ſee that theſe Semi-circular Veſſels, 1, 2, 3, have an Opening at each End into the *Veſtibulum*, but that two of 'em 1 and 2, are united in one Veſſel at 5 and 6: And therefore, that there are not ſix but five Orifices in the whole: Moreover, we ſee on the ſide oppoſite to the Porch the *Cochlea* 4, this is divided according to its Length and Bending into two particular Tubes by a kind of a *Septum* or Partition-Membrane; which likewiſe, according to its Length, conſiſts of two different Sorts of Matters; the one is membranous, which *Valſalva* (ſee his *Tab.* VIII. *Fig.* 7.) thinks is probably formed from a Branch *e*, of the Soft Auditory Nerve ſpread out into a Membrane (*Tab.* XI. *Fig.* 7. And the other kind of Matter is dry, thin and rough, according to *Du Verney*, and between the ſolidity of a Cartilage and a Membrane, as *Valſalva* ſays of it. That at leaſt ſeems to be true, that this Matter renders the *Septum* very fit for propagating the Tremulous Motion of the Sound.

Of the two Tubes which are made by this *Plate* in the *Cochlea* 4, one is ſhut up in a Membrane, and the round Window *p*, of which mention is made above (*Tab.* XI. *Fig.* 5.) in the Opening itſelf

So

So that between this Tube, or rather between the half Cavity of the *Cochlea* and the Drum's Cavity, nothing but this Membrane does appear.

Tab. XI. *Fig.* 6. *r* is likewiſe the Orifice of another Tube, which is open at the *Veſtibulum.*

The Anatomiſts name both theſe Tubes, into which the Cavity of the *Cochlea* 4 is divided, the *Scala* or Stairs.

Laſtly, we find that the *Veſtibulum* (beſides the five Openings of the Semi-circular Veſſels, one of the *Cochlea*, and ſtill five others thro' which the Auditory Nerves paſs, and by which theſe Openings are ſtopt) has yet one more repreſented (*Tab.* XI. *Fig.* 5.) by *o*, and *Fig.* 6. by *q*; *viz.* the aforemention'd Oval Window, which is ſtopt by the little Bone of the Ear called the Stirrup; yet in ſuch a manner, that the Membrane which is between that Bone and the Edge of this oval Opening or Window, gives a Liberty to the Stirrup to be moved upwards and downwards.

Sect. IX. *The Auditory Nerves.*

Before we go any farther, we muſt ſay ſomething of the Auditory Nerves, the Soft Parts whereof *c d* (*Tab.* XI. *Fig.* 7.) being divided into five Branches, paſs thro' the aforeſaid Openings into the *Veſtibulum*, where being expanded, they compoſe the Membrane of this *Veſtibulum*; and from this Membrane likewiſe, there proceed five others, which entering into the Semi-circular Veſſels, and coming with each other from both ſides, are united in one Membrane. You may ſee 'em in this Figure, which appears ſufficiently in *Fig.* 6. If inſtead of the Tubes you ſuppoſe you ſee the Membranes which are there, and which are made of the expanded Auditory Nerves.

So

So likewiſe, according to *Valſalva*, the little Branch of the Nerve *e* in the *Cochlea*, produces the Membrane *g*, which, as we ſaid before, makes one ſide of the *Septum*, that divides the whole *Cochlea* into two Tubes.

Sect. X. *All the Inſtruments of Hearing ſhewn.*

After all theſe Particulars, we ſhall proceed to repreſent the entire Structure of the Inſtruments of Hearing jointly with one another, and at the ſame time, give you a brief Account of the Opinions of the Principal Anatomiſts concerning their reſpective Uſes: You may ſee them in *Tab.* XII. *Fig.* 1. which, to range them in order as they appear, did not coſt a little trouble to *Valſalva*, as he himſelf ſays of it.

Here then we find the Ear repreſented, not as it is ſeen before, or as it is extended towards the Face; but inflected a little towards the hinder Part of the Head, to ſhew all the other Matters more plainly.

A A is the Ear, in which the Sound is incloſed; and B the *Cochlea*, or Shell, in which the Sonorous Air is collected, which, paſſing from thence into the Auditory Tube C C, ſtrikes upon the Membrane of the Drum *e g o*, and thereby communicates a Tremulous Motion to the ſaid Membrane.

Sect. XI. *An Experiment ſhewing that the Auditory Tube increaſes the Sound.*

It muſt not be thought that this is ſaid without any ground, ſince it is very probable, that the Air paſſing thro' the *Cochlea* B, and the Auditory Tube C C (which together make a natural Speaking-Horn or Trumpet) ſtrikes much more ſtrongly upon the Drum-Membrane that ſhuts the ſaid Tube

Tube, than if it ſtruck againſt the ſaid Membrane, without paſſing thro' this Tube.

This is plain in ſuch as are Deaf, and who are obliged ſometimes to put into their Ear, either a crooked or ſtrait Tube, the Mouth of which is large, and the lower part narrower, in order to hear the better.

And if a Man that is not deaf has a mind to make the Tryal, let him take one of thoſe ſpeaking Trumpets that were invented in the laſt Century (ſee *Tab.* XII. *Fig.* 2.) A E, and ſet the narrow Part of it againſt his Ear, and let ſome Body whiſper ſoftly at the wide Part E; and he ſhall find, tho' the Tube be about Six Foot long, as mine is, that he will hear the Speaker very plainly and diſtinctly, even at the time when other Perſons ſtanding much nearer to the Mouth of him that ſpeaks, and liſt'ning with all the Attention they can, will not be able, by reaſon of the lowneſs of his Voice, to hear or underſtand any thing he ſays.

After the ſame manner we likewiſe perceive, that the Sound produced by blowing thro' a Trumpet or Horn, is heard incomparably louder than that which any Man can make with his Mouth only.

Sect. XII. *Sounds produce a Tremulous Motion in the Drum-Membrane, ſhewn Experimentally.*

Now to ſhew farther, that the Air operating more ſtrongly upon the Drum-Membrane *c g o*, thro' this natural Auditory Tube A A B C C (*Tab.* XII. *Fig.* 1.) produces therein a ſhivering or tremulous Motion, one might firſt inſtance in the manner that all reſounding Bodies are moved, which, vibrating ſwiftly backwards and forwards, ſtrike againſt the *Circumambient* Particles of Air, and ſo

municate this tremulous Motion. One may perceive this ſame tremulous Motion very ſenſibly in Bells, in the Strings of Muſical Inſtruments and other things, by laying ones Finger or any other Matter upon them when they are made to ſound; and very plainly in the known Experiment of a Drinking-Glaſs, with a little Water in it, by wetting the Finger and preſſing it round the Brim; and at the ſame time that it yields a Sound, if you place the other Hand at the Foot or Bottom of the Glaſs, you may feel the ſaid tremulous Motion.

And to ſee, by way of Compariſon, how the Air is moved by ſuch a reſounding Glaſs, you need only pour as much more Water in it, which will fill it almoſt to the Brim, when preſſing the ſaid Brim round again with the Finger, you will viſibly diſcover in the Water, the tremulous Motion occaſion'd by the Glaſs; juſt ſo is the Air likewiſe moved.

SECT. XIII. *Other Experiments proving the ſame thing.*

BUT not to diſcourſe too long nor too deeply about the Nature of Sounds, which are not yet fully known to us, this is ſufficiently certain, that after what manner ſoever the Air be put into Motion, in order to produce Sounds, it is capable of cauſing the Bodies againſt which it ſtrikes to tremble.

Now, to ſay nothing here of thoſe Motions which the Sound of a Cannon produces in the Air, and by which it cauſes Doors and Glaſſes, with many other ſolid Bodies, not only to tremble, but to burſt in pieces; this is very plain, that if you ſtrike with your Finger upon the Thread or String of a Muſical Inſtrument, for inſtance, a Violin;

the other Hand, in which you hold the ſaid Inſtrument, will in ſome meaſure feel the Wood to tremble.

But now to ſhew the Analogy thereof with the Ear, about which we have been treating; take away the Mouth Piece of the Speaking-Trumpet, A, B, C (*Tab.* XII. *Fig.* 2.) and inſtead thereof, let a dry thin Hogs Bladder be ſpread over the Orifice as ſmooth and tite as may be; or in caſe the Brim or Edge of the ſaid Trumpet B C, be armed with a kind of Teeth, as ſome are for Ornament-ſake, and that there be danger from thence of burſting the Bladder in the Expanſion thereof, you may put a four-double Paper, with a great round Hole in the middle, upon thoſe Teeth, before you ſpread the Bladder over them; this being done, let the Trumpet, with its largeſt Orifice D F, be placed upon the ſide of two Chairs, ſo that it may ſtand ſtreight up, and the Bladder be on the Top at B C.

Now in caſe you ſhould lay three or four little Feathers of a Quill upon the ſaid Bladder, and cauſe a Man lying upon his Back upon the Floor, with his Head between the two Chairs, and his Mouth directly under the middle of the Tube E, to call or ſpeak out aloud, you ſhall perceive, that the Sound ſtriking upon the Bladder, will produce a tremulous Motion in the ſame, and in the little Feathers lying upon it; which Motion, or Trembling, may be likewiſe felt, if you hold the Tube in your Hand, and lay your Finger upon the Bladder at B C, when any Body ſpeaks whoſe Mouth is placed at E.

Thus then we ſee (taking the Speaking-Trumpet for the Auditory Tube A A B C C (*Tab.* XII. *Fig.* 1.) and the Bladder for the Drum-Membrane, which is expanded over the Auditory Tube at e g O; that the ſaid Membrane muſt be affected with a tremulous Motion, by the Sound entering

the Ear, as alſo the Hammer *n*, whoſe Stalk o
Handle is faſten'd to the Drum-Membrane.

Sect. XIV. *The Tremulous Motion of the Auditory Bones.*

Now by this Hammer muſt the little Nerve *c* 7 (which ſhews itſelf here between the Hammer *n* and the Anvil *m*) be likewiſe moved; of which we ſhall ſay ſomething more hereafter. But it is particularly plain that the Hammer *n*, being moved by the tremulous Motion of the Drum-Membrane propagates the ſame Motion to the Anvil *m*, and by that to the Stirrup *p*.

The Stirrup *p*, which does here cloſe the Oval Orifice in the Porch 4, both by itſelf and the Membrane that ſurrounds it (this Orifice does not appear very plain here, but you may ſee it in (*Tab.* XI. *Fig.* 5. at *o*, and *Fig.* 6. at *q*) being thus put into a tremulous Motion, both by the Sound and by the trembling of the Drum-Membrane, and the reſt of the Auditory Bones; we likewiſe ſee that the Air in the Porch 4, and moreover in the Semicircular Veſſels 1, 2, 3, and in the one Tube or half of the *Cochlea* 5, will be moved; and alſo through the round Orifice *p*, (*Tab.* XI. *Fig.* 5.) the Air in the other Tube, not like the former (*Tab.* XII. *Fig.* 1.) by the Auditory Bones, or by the Hammer *n*, the Anvil *m*, and the Stirrup *p*; but by the Motion of the Air in the Cavity of the Drum, which is to be found between the Drum-Membrane and this round Orifice; which Air being moved by the Drum-Membrane, and likewiſe by that Membrane that cloſes the round Orifice *p* (*Tab.* XI. *Fig.* 5. and the Air *Tab.* XII. *Fig.* 1.) that is behind in the other half Tube of the *Cochlea* 5, will be moved. This is the Opinion of Monſieur *du Verney*, about the round Window, from whom

whom *Valſalva* does herein ſomewhat differ: They that pleaſe may conſult 'em both, or ſtay till the uncertainty of the Uſe of this round Orifice be removed by future Experiments. But to proceed:

Sect. XV. *The like Motion in the Membrane of the Labyrinth.*

This Air being put now into Motion throughout the whole Labyrinth 1, 2, 3, 4, 5 (*Tab.* XII. *Fig.* 1.) The Membranes (that are therein, and are repreſented by *Fig.* 7. *Tab.* XI.) or rather the Auditory Nerve 6, muſt needs be moved thereby; which Nerve enters this Labyrinth thro' five Orifices (*Tab.* XII. *Fig.* 1.) three of which are ſeen on this ſide the Porch like ſo many Points; and being there, and ſpreading out its Branches into Membranes (when they are moved by the Air) as well in the Porch as in the three Semi-circular Veſſels, and the *Cochka*, the Senſe of Hearing is thereby produced.

So that finally theſe Nervous Membranes in all the Cavities and Tubes of the Labyrinth 1, 2, 3, 4, 5, ſeem to be the Inſtruments by which, and the Labyrinth itſelf the place where, the Hearing is formed, becauſe the Motion of the Sound does there affect the Auditory Nerves, or the Membranes produced by the Expanſion of the ſame.

Now that this is not advanced by many, without good Grounds, ſeems to be in ſome manner proved by an Obſervation which *Valſalva* made upon the Body of a Deaf Perſon. *Ch.* II. §. 10. where the Membrane that encompaſſes the Stirrup, and ſhuts the Oval Orifice, was found to be all Bone, and for that reaſon the Stirrup was immoveable, which, according to him, was the Cauſe of that Deafneſs; to which we may add, that the Drum-Membrane being broken, the Hear-

ing does not immediately fail, but only after a good while, when the other Inſtruments of Hearing, lying too naked and expoſed to the Air, are perhaps corrupted. So that properly the Drum-Membrane does not ſeem to be the immediate Inſtrument of Hearing.

Sect. XVI. *Conviction from ſome Particulars.*

I now leave it to the Judgment of an Atheiſt himſelf, how many things relating to the Uſes of theſe Inſtruments of Hearing may be ſtill concealed from us; or, whether ſo many as are hitherto known to us, are formed and fixed in the Place where we find them by mere Chance, or without a wiſe Deſign?

Dares he now aſcribe the Figure of thoſe little Trumpets or Horns that Deaf People make uſe of, to Chance, or ignorant Cauſes? Can he then with the leaſt Appearance of Reaſon, advance ſuch Sentiments of this which is found in the Ears of all Men L L, and is repreſented in *Tab.* XI. *Fig.*3. by the *Concha* K, and the Auditory Tube A B C.

Eſpecially knowing, as he does, the Inconveniencies which any little Things or Inſects produce, when they get into that Tube; and ſeeing beſides, that that Veſſel is encompaſſed with a number of ſmall Glands at A, which have likewiſe their own little Veſſels, from whence a tough and yellow Matter is continually filtrated; the Uſe whereof is not only to preſerve the Tube in a proper State of moiſture, ſo that it may not be too much dryed by the Air, nor yet render'd too ſoft and flabby, if the ſaid Matter were thinner; but chiefly to ſtop the way to the innermoſt Part of the Ear, and Barricade it againſt little Flies and other little Animals by the aforeſaid tough Matter, and alſo by the little Hairs that grow there-

in

in; and in caſe any of thoſe little Creatures ſhould have inſinuated themſelves too far, the Bitteriſh Taſt of that Matter will deter them from advancing any further.

The Wonders of this Structure of the Ear, ſo far as they relate to the little Muſcles placed therein, may be ſeen in the Book of thoſe who have learnedly treated of the ſame, ſuch as *Valſalva*, *Du Verney* and others: *d* is one of thoſe Muſcles repreſented in *Tab.* XII. *Fig.* 1. as ſeparated from the Bone-Tube in which it is placed; which alſo ſerves to draw the Hammer, and thereby more or leſs to expand the Drum-Membrane, and, together with the other Muſcle *ff*, to open at the proper time the Tube H I, which runs from the Cavity of the Drum, to the hindmoſt Part of the Roof: At *g* we ſee a ſmall Muſcle, which is implanted in the Head of the Stirrup, and which can ſtretch more or leſs the little Membrane that ſhuts the Oval Orifice, in order to render it more Serviceable to the Motion of the Sound. But this we ſhall paſs by.

Sect. XVII. *The Difference between the Inſtruments of Hearing in Young and Grown People.*

Now if the Wiſdom of the Creator does not palpably appear from all the foregoing, let any reaſonable Body judge, when he ſees that in *Tab.* XII. *Fig.* 1. the little Bones of Hearing *n*, *m*, *p*, and thoſe that compoſe the Labyrinth 1, 2, 3, 4, 5, are of the very ſame Size in a little Child as in a grown Man; whereas all other Bones do moſtly grow with the Body; the reaſon of which, as it ſhould ſeem, is, that in caſe the Inſtruments of Hearing ſhould alter, the Voice of the Children themſelves, of their Parents, and other Sound already known to Children, might, by the growth

of theſe Inſtruments, become ſtrange and uncouth to them, and ſo occaſion Miſtakes and Confuſion.

And to be convinced, that this happens with Deſign, and merely by the Wiſdom of the Creator, we need only take notice, that where it is neceſſary that all theſe things ſhould remain in the ſame State in a Child and in a grown Perſon, the ſame does accordingly happen; but when any Alteration is neceſſary, that alſo happens: Accordingly in a grown Perſon it is neceſſary that the Auditory Tube BCC, ſhould be wholly open to the Drum-Membrane *c*, *g*, *o*, *c*, and the Membrane of the Drum itſelf dry, and not too flabby; But if this ſhould happen in the ſame manner in Children, that Moiſture, with which they are encompaſſed before their Birth, would render the Drum-Membrane too ſoft and flabby to be of uſe to them afterwards: From whence it is, as Anatomiſts obſerve, that the Auditory Tube in new-born Children, is narrower, and ſtopt by another kind of Matter, inſomuch, that the Humidity of the Matrix cannot approach it; which ſtopping Matter is found to diſappear of itſelf in a few Days after the Birth, to accuſtom the Children by degrees to the Impreſſion of the Air upon the Drum-Membrane, and ſo to the Senſe of Hearing, of which they are deprived even after their Birth, ſo long as this Obſtruction laſts in the Auditory Tube.

Sect. XVIII. *The Inſtruments of Hearing are unneceſſary without Air. Convictions from thence.*

Now, as the Eye without Light, ſo this wonderful Structure of the Inſtruments of Hearing, would be in a manner uſeleſs, if he, that takes ſuch great Care of all his Creatures, had not vouchſafed to encompaſs that Globe upon which they live with a vaſt Ocean of Air. Does not

not this then adminiſter an occaſion to us alſo, to praiſe the Goodneſs and Wiſdom of the Creator, who has been pleaſed ſo to adjuſt theſe Inſtruments of Hearing, that whilſt Men live and breath in the Air, they are exactly adapted to diſcover to us, after ſuch a wonderful Manner, the Motion thereof, by means of an Impreſſion which the Sound produces in us; and which is only applicable to this Senſe of Hearing?

Will any one dare to maintain, if he ſaw a Ship ſailing with all its Tackle, that the Ropes, Sails, Pullies, and whatſoever elſe is neceſſary to adapt it to the Wind, are put into ſuch a State by mere Chance, or without Deſign; and yet that every one of them was very uſeful in cauſing the Ship to move? And is it not much more unreaſonable to aſſert the ſame of theſe much more wonderful Things, which, as to the manner of their Operation, have hitherto been inſcrutable? For theſe are not governed by a ſtrong and ſenſible Motion of the Air, ſuch as the Wind is, but are adapted by a much more ſecret and inſenſible Motion thereof, with the Aſſiſtance of ſeveral Muſcles, which dilate or contract theſe Inſtruments of Hearing: And yet it muſt be confeſs'd, that the Uſes and Advantages of ſuch a Motion are much greater than that produced by the Wind in a Ship, in which latter a very few may be concerned, but the former affects all living Creatures; and the Benefit thereof is communicated to them after the moſt convenient Manner, and even without any Concurrence or Trouble on their Part.

Sect. XIX. *The Nerves that are moved in Hearing.*

To proceed now to thoſe other Matters of which we promiſed to ſay ſomething in the following Diſcourſe: We have ſhewn before, in *Tab.* XI. *Fig.* 3. a ſmall Nervous Body E O (which in *Tab.* XII. *Fig.* 1. is repreſented by *c* 7) This is obſerved to run acroſs over the Drum-Membrane, between the two Auditory Bones, *viz.* the Hammer C S, and the Anvil B P; and foraſmuch as the Hammer C S is faſten'd to the ſaid Drum-Membrane, tis plain enough, that that Membrane being moved by Sounds, ſuch Motion muſt neceſſarily be continued to the Hammer, and to the ſaid Nervous Cord or String E O: So that in every Motion of the Drum-Membrane, that is, as often as one hears any thing, this little Nerve E O, is put into a tremulous Motion.

Sect. XX. *The Uſe of the ſaid Nervous Cord.*

Concerning the right Uſe of this little Nerve the Opinions of the Anatomiſts are various, all of 'em looking upon it as a thing ſufficiently obſcure. It is called by the Ancients *Chorda Tympani*, or the String of the Drum, and eſteemed to be of the ſame Uſe as the Strings of the Soldiers Drums.

Mr. *Maurice Hoffmann* in his *Idea Machinæ*, p. 232. has collected the ſeveral Notions of the Learned about this Nervous String. *Fallopius*, ſays he, was uncertain what it was; *Euſtachius* takes it for a Branch of the Nerves of the Fourth Pair; notwithſtanding which Mr. *Gaſper Hofmann* acknowledges ingeniouſly, that he did not know what ſort of a Body this was, nor to what End, nor where it was inſerted

inſerted; and thought that it might be an uncertain Work of ſporting Nature, and that a great many were miſtaken concerning it. Whereupon *Riolanus* having ſince anſwer'd him, ſays, that it is a nervous Fibre derived from the Auditory Nerve. Finally, Monſieur *du Verney* has irrefragably proved, that this nervous Cord is a Branch of the Fifth Pair, which proceeding forwards, joins itſelf to the hard Auditory Nerve.

The ſaid Monſieur *Du Verney* lays down the Uſe thereof in his Treatiſe *de Organ. Audit. p.* 12, 13. ſaying, that it communicates Branches to the little Muſcles of the Auditory Bones, and what elſe there may be in the Cavity of the Drum, in order to produce Motion.

Monſieur *M. Hofmann* ſuppoſes, that it ſerves to communicate Motion and Senſation to the Drum-Membrane, at leaſt to give it its proper Tenſion.

Touching this String, the Reader may conſult *Valſalva*, who having written later than the above-mention'd Gentleman, has declared his Opinion with ſome Warmth in his Accurate *Deſcription of the Ear, Cap.* II. §. 22. Theſe are his Words as they ſtand there; *Moreover, that this nervous Branch runs ſo naked and undiſcover'd, ſo ſimple and alone, ſo regularly and ſo conſtantly thro' the Cavity of the Drum, and particularly that it lyes ſo between the Auditory Bones, that it is imediately put into Motion as ſoon as ever the ſaid Bones are moved; all theſe things ſhew, that there is ſome great Myſtery of Nature concealed in this Branch, and have therefore induced me frequently to contemplate the ſame both with my Eyes and my Mind, being deſirous to find out ſomething perhaps new in the Diſſection, or at leaſt the Cauſes thereof.* After which he tells us what his Thoughts were concerning it, and what he had begun to diſcover therein, and ſo concludes with theſe Words: *But ſince I have not yet had an Opportunity to employ ſo much*

Pains

Pains as I was deſirous, and as was requiſite in this Matter, I ſhall content my ſelf with having made known my Intentions and Purpoſes, and ſay no more about it at preſent.

This Gentleman does likewiſe own, that this Branch lyes between the Fifth Pair and the Auditory Nerve; but adds, that he can't ſee, why we may not as well take it for a Branch of this Auditory Nerve, carried on to the Fifth Pair, as a Branch derived from the Fifth Pair to the ſaid Auditory Nerve: But whether we maintain it to be the firſt or the laſt with Monſieur *Du Verney*, it is certain, that this String has likewiſe a Communication with the Fifth Pair; and that being put into Motion by Sounds, it cannot avoid continuing ſuch Motion, both to the Fifth Pair and to the Auditory Nerves.

I have been more prolix in relating the Sentiments of the Principal Anatomiſts upon this Matter, to ſhew that this little nervous Cord has occaſion'd very ſerious Reflections among ſeveral Perſons, and that many have ſuſpected, that there is ſomething ſtrange and uncommon therein: And I ſhould not have offer'd my own Opinions concerning the Operations of the ſaid Cord, and the Purpoſes for which it ſeems to be made, were it not to convince the Atheiſts and Unbelievers, or at leaſt Weak and Wavering Chriſtians, that they will find ſomething in the Structure and Contrivance of this String, that may excite in them not only Admiration, but alſo Reverence for the adorable Maker of it. To propoſe it therefore briefly:

SECT. XXI. *The Fifth Pair of Nerves ſerve to excite the Paſſions.*

How much the Fifth Pair of Nerves contributes towards exciting our Paſſions or Inclinations, with reſpect to the *Intercoſtal Nerves*, which iſſuing frequently with a double Branch out of the ſaid Fifth Pair, liberally communicates Sprigs to all the Parts of our Body, and cauſes Motions therein, may be learned from the Words of this great Enquirer into the Nerves, *Vieuſſens*, *p.* 236 in 8*vo.* who ſays, That *the ſaid Pair is not only carried on to the Eyes, Noſe, Palate, Tongue, Teeth, and all the Parts of the Mouth and Face, but that it likewiſe derives its Branches to every thing that is in the Breaſt and Belly, and is even continued down to the Feet by the Intercoſtals*; Adding farther, *p.* 327. that this Communication of the Branches of the Fifth Pair is, among other things likewiſe, the Cauſe why, purſuant to the various Motions that are produced in the Brain, all the Parts of the Body, and particularly of the Breaſt, are differently affected, and the Signs of our Inclinations impreſſed upon our Faces, which are altogether adapted to thoſe Paſſions that are moved; and accordingly by the Changes of our Countenances, the ſeveral *Emotions*, or Affections, of Love and Hatred, of Joy and Sorrow, of Fear and Boldneſs, are clearly expreſſed.

SECT. XXII. *The* Dura-Mater *produces the like Emotions.*

Secondly, How much the Motions of the *Dura-Mater*, which encompaſſes all Nerves, do likewiſe contribute to the producing theſe Paſſions and Emotions in the Mind, is known to Surgeons when they touch the ſame, and to Phyſicians too, very fre-

frequently in the Diſtemper called the *Phrenitis* Frenſy in which it appears that by the pricking of this Membrane (whereby its Expanſion is augmented, and the manner of Motion alter'd) confuſed Thoughts and extravagant Paſſions, ſometimes Weeping, then again a ſudden fit of Laughter; one while Fear, another while Boldneſs and Anger, and innumerable other irregular Motions in Actions and Words, without any external apparent Cauſe, are produced in the poor Patient. Now this great Inſtrument of ſo many Actions, this *Dura-Mater* has many of its Nerves from the Fifth Pair, as the ſaid *Vieuſſens* has ſhewn in ſeveral Places, ſo that that is likewiſe moved thereby.

Sect. XXIII. *The Eighth Pair produces the ſame Effects.*

Thirdly, It may be likewiſe obſerved from the ſaid *Vieuſſens*, *p.* 347. that in many Caſes, the Nerves of the Eighth Pair, which the Ancients Name the *Wandering Nerves*, or *Parvagum* encompaſs thoſe of the Fifth Pair in their Operations; and conſequently in many Places, by the interpoſition of the Nervous Branches, thoſe of the Eighth Pair are inſerted in the Intercoſtals which proceed from the Fifth Pair. And how much therefore thoſe of the Eighth Pair do likewiſe help to excite the Paſſions, appears from the ſame Author, *p.* 347, and 348. where he ſays, *Since the Eighth Pair has a Communication with the Auditory Nerves about the Origin thereof, we find the Reaſon why not only different Paſſions are excited in the Soul, according to the differences of Sounds, but alſo why the Heart and other Parts, yea, even the whole Body, are variouſly affected thereby.*

Sect.

SECT. XXIV. *The Auditory Nerve produces the like Effect.*

Fourthly, WE find the aforemention'd Monſieur *Vieuſſens*, diſcourſing about the Auditory Nerves in the following Manner; *Theſe Auditory Nerves riſe cloſe to the Root of the Eighth or Wandering Pair, with which the ſofter Branch of the ſaid Nerves runs along; whereby it comes to paſs, that there is ſuch a great Sympathy between the Ear and the Bowels, which are provided with this Eighth Pair. That according to the variety of the Sounds, various Motions are produced not only in the Brain, but likewiſe in the Breaſt, and oftentimes in the whole Body, and thereby* (viz. *on occaſion of theſe Motions*) *various Notions and Conceptions are excited in the Soul.*

Beſides all this, it is likewiſe found that the harder Auditory Nerve is likewiſe inſerted in the Eighth and Fifth Pair, and alſo ſends a Branch to the *Dura-Mater*, beſides thoſe which it gives to the Inſtruments of Hearing. See *Vieuſſens*, *p.* 340, and 341.

SECT. XXV. *The Motion of the* Chorda Tympani *does likewiſe excite the Paſſions.*

FROM all which it is therefore plain, that by the Motion of the Fifth Pair, and by that of the Auditory Nerve, our Paſſions are excited; and that the Fifth Pair produces this Effect both from itſelf, as it ſends ſeveral Branches to the *Dura-Mater*, and a great many to the Eighth Pair, which Eighth Pair does likewiſe excite the Paſſions: The Auditory Nerve alſo has the ſame Effect, becauſe it is inſerted in the Fifth and Eighth Pair, and in the ſaid *Dura-Mater*.

Now

Now foraſmuch as it has been already ſhewn that the Drum-Membrane, which is moved by every Sound, can undergo no Motion unleſs the Auditory Bones, and by them the *Chorda Tympani* EO (*Tab.* XI. *Fig.* 3. and *C.* 7. *Tab.* XII. *Fig.* 1.) be moved at the ſame time; and foraſmuch as *Du Verney* and *Valſalva* have both proved that this is a Branch lying between the Fifth Pair and the hard Auditory Nerve, and inſerted in both; it follows, that this *Chorda* being always moved by Sounds, both theſe Nerves muſt likewiſe ſhare in the ſame Motion: Wherefore it is manifeſt, that the Operation of this *Chorda* does likewiſe, among other things, conſiſt herein, to bring the Body into Emotions or Paſſions of Mind by theſe Nerves, or at leaſt to diſpoſe and prepare it for the ſame.

Sect. XXVI. *Why the Hearing above all other Senſes, is beſt adapted to theſe Purpoſes.*

The *Sight* is commonly eſteemed the moſt excellent of all the Senſes; and Experience itſelf has made it a Proverb, That one Witneſs, who has ſeen a thing, is more to be credited than ten that have heard it; which may be the reaſon, perhaps, that the *Hearing* may be adapted by its Structure, even beyond the *Sight*, to ſtir up Paſſions and Emotions in Humane Minds.

But conſidering that the Great God, according to his endleſs Wiſdom and Mercy, has thought fit to propagate Saving Faith in his adorable Son by the means of *Hearing*, as well before he took upon him Humane Nature, as particularly after that he left this World and enter'd into his Glory: It ſeemed to me (if one may preſume to ſay any thing of the Wiſe Deſigns of the Almighty, when they are not fully reveal'd to us) for theſe Reaſons, that the Inſtruments of Hearing have received

ſuch

fronting page 268.

TAB. XI

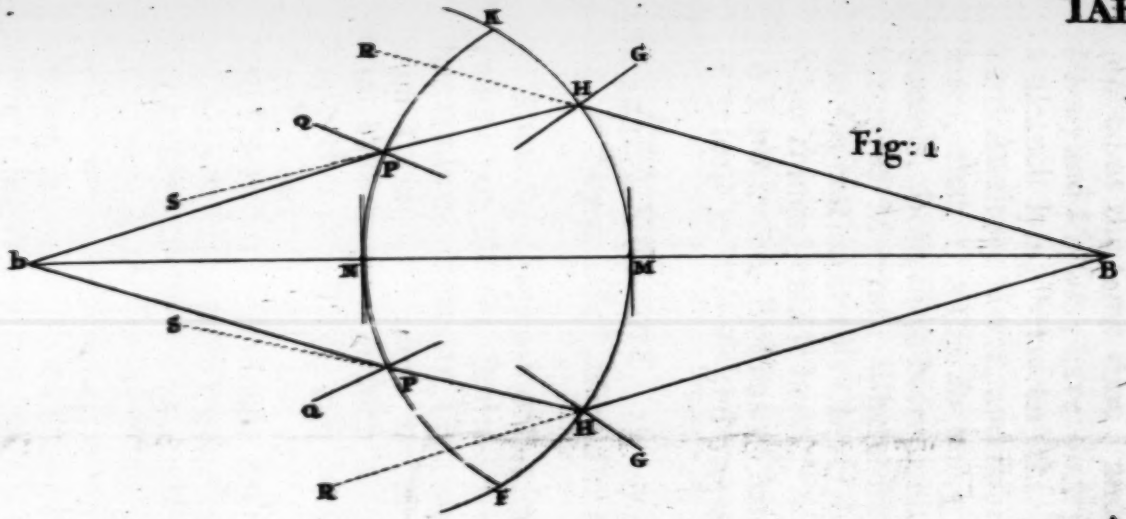


Fig: 1

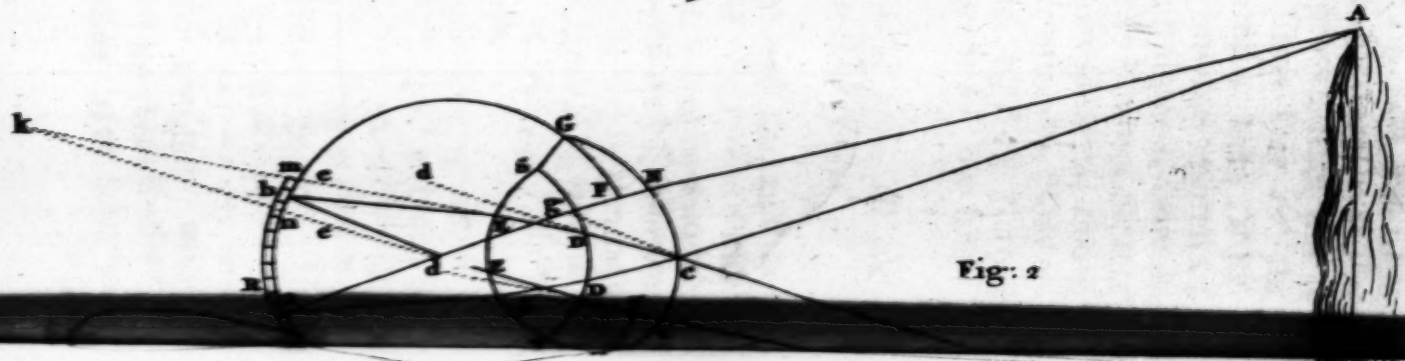


Fig: 2



Fig. 4



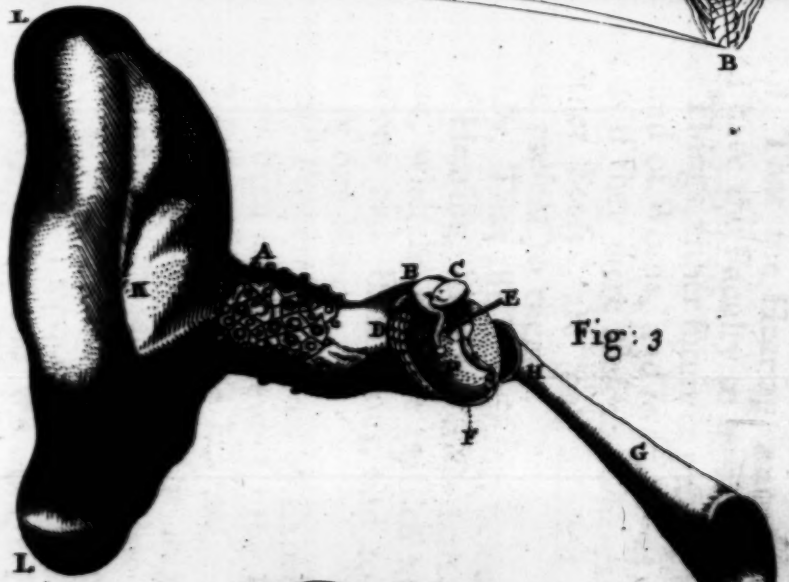


Fig: 3



Fig. 5

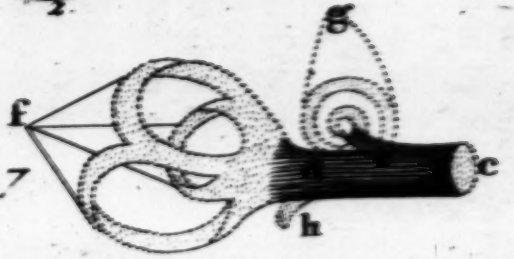


Fig. 7



Fig. 6



ſuch a different Contexture from thoſe of all the other Senſes. For in order to adapt them for ſo unconceivably a great Work, the following Properties are neceſſary thereto.

Firſt, That the Hearing, among all the Senſes, ſhould have the Faculty to repreſent to the Mind abſent Things, either future or paſt, by the means of the Sound of Words, and to make us comprehend them as if they were preſent; whereas the Sight, and other Senſes, are only affected by Objects that are preſent to them.

Secondly, That the Inſtruments belonging to the Senſe of Hearing, have moreover ſuch a particular Structure, whereby they are enabled to excite all our Paſſions and Inclinations, and to awake the Powers of our Minds.

The firſt Property is proved by Experience; the ſecond has been already ſhewn by the Deſcription we have given of the *Chorda Tympani*, and the other Inſtruments of Hearing, to which might perhaps be added as another Cauſe, *Firſt*, that the Drum-Membrane itſelf conſiſts of the Union of two other Membranes, one of which is the Skin of the Auditory Tube, and the other a Part of the *Dura Mater* which extends itſelf thereto. *Secondly*, that the Air which is put into Motion by Sound, can immediately affect the *Dura Mater* by the little Holes in the Cavity of the Drum, and by the Tube which is continued from thence to the Palate. Theſe Diſcoveries we owe to *Valſalva*. But this we leave to the further Conſiderations of the Learned; Let it ſuffice here, that it has been plainly enough proved, that thoſe Inſtruments that belong to the Senſe of Hearing are adapted to excite the Paſſions.

Sect. XXVII. *An Experiment to ſhew the Force of Muſick.*

In the *Hiſtory of the Royal Academy in* France, *for the Year* 1717. (under the Head of *Obſervations upon Phyſicks in General*) we find a relation of a great Muſician, and in the Hiſt. of 1708. of a Dancing-Maſter; the firſt of whom was taken with a continued Feaver and great Ravings; and the laſt with a very violent Feaver, attended with a kind of Lethargy, and afterwards with Madneſs; and that both of 'em were perfectly reſtored to their Senſes by Muſick.

We alſo find ſeveral Obſervations made upon Perſons that have been ſtung by a *Tarantula*, a Creature found in *Italy*, of the Shape and Size of a great Spider, which has produced the extreameſt Diſorders in their Underſtanding, Motions and Powers of Life; the Faces of ſome turning black, their Feet and Hands as if they were Dead; others lying Speechleſs, or in deep Melancholy, ſeeking Solitary and Burying Places; ſometimes digging Pits and Holes, which they fill with Water, and wallow in the Mud thereof like Swine; finally, after having undergone innumerable Miſeries, their Diſtempers have only ended with their Lives.

I ſhall not enquire into the Cauſes thereof, but we are taught by Experience, that this Great Evil, for which hitherto no other Remedy is known, can only be cured by the Sound of Muſick, on which different Aires and Tunes muſt be played according to the different Nature and Colour of thoſe *Tarantula's* that have given the Wounds.

They that deſire a fuller Information of theſe Matters, may be pleaſed to conſult what Signior *Baglivi* has ſaid about it.

Whilſt

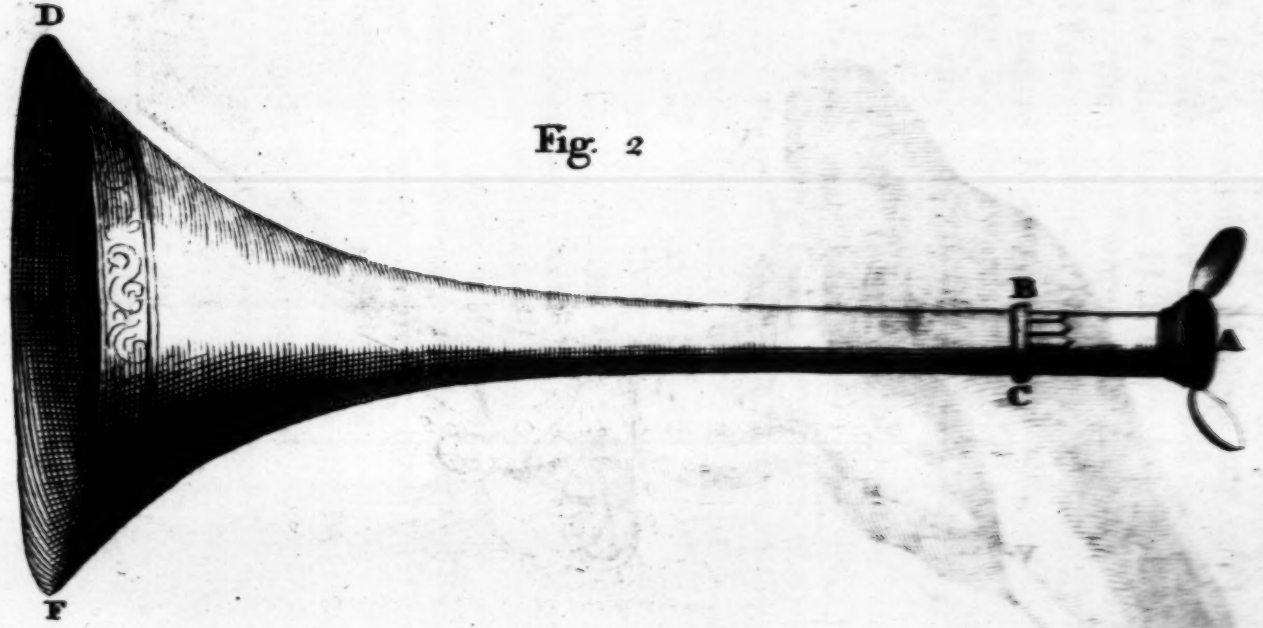
f210

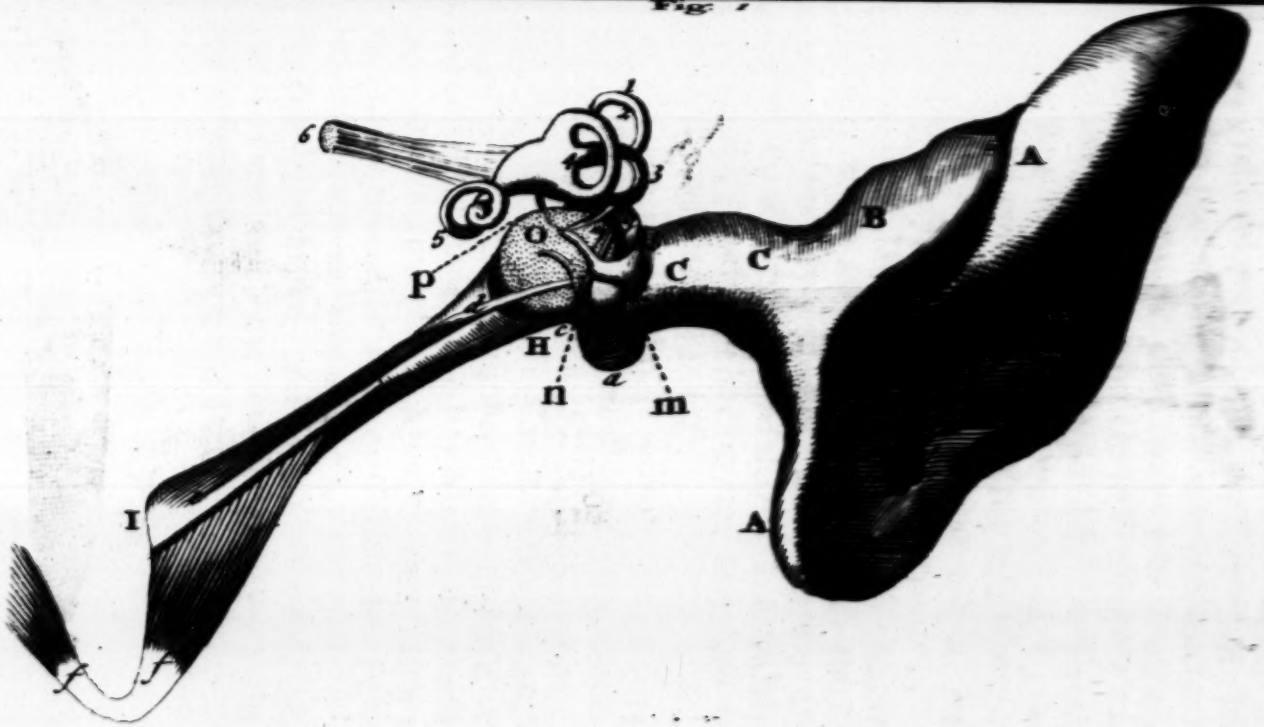


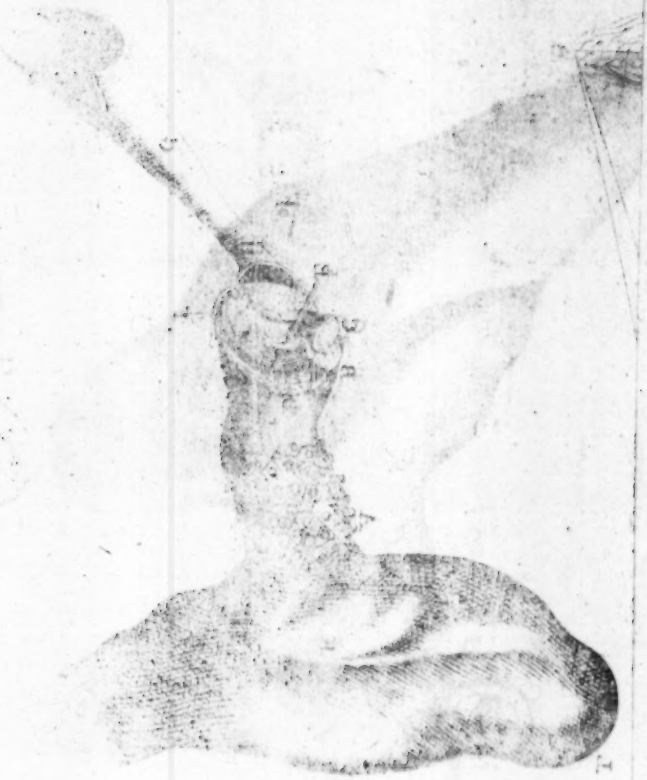
fronting page 270

TAB. XII

Fig. 2




A
B
C
C
o
p
H
n
m
I
A
A



Whilſt I was writing this, a certain Learned Gentleman, and a Great Maſter in Muſick, did me the Honour of a Viſit; and as our Diſcourſe occaſionally fell upon this Subject, was pleaſed to inform me that the famous *Italian* Muſician, *Angelo Vitali*, had related to him the following Story, and aſſured him of the Truth of it: Namely, that a certain Player upon the Lute at *Venice* had boaſted, that by his playing he could deprive the Hearers of the uſe of their Underſtanding; whereupon he was ſent for by the *Doge*, who was a Lover of Muſick, and commanded to put his Art in Practice before him; where, after having played ſometime very finely, and to the amazement of the Hearers, he at laſt began a Mournful Tune, with a Deſign, as far as he was able, to put the *Doge* into a Melancholy Humour, and preſently after, he ſtruck up a Jovial one, to diſpoſe him to Mirth and Dancing; and after having repeated thoſe two kind of Tunes ſeveral times by turns; he was order'd by the *Doge*, who ſeemed to be no longer able to endure thoſe different Emotions which he felt in his Soul, to forbear Playing any longer.

Now that ſuch ſudden Variations in Tunes, by which Men are in one Minutes time render'd very Sorrowful, and the next no leſs Merry, do produce ſtrange Effects upon our Minds, may eaſily be conceived by thoſe that have ever felt the Power of Muſick from an able Hand: At leaſt, it is very plain from hence, and from numberleſs other inſtances, how much the Senſe of Hearing contributes towards exciting the Paſſions.

Sect. XXVIII. *The Force of other Sounds.*

However, let no Body think that nothing but good Muſick is capable of exciting Paſſions and Diſorders in the Minds of Men, ſince we have ſeen the like Effects produced by the other Sounds. Every Body can furniſh Inſtances of the extraordinary Emotions and Paſſions which the Noiſe of a Drum, and the Diſcharge of Guns, do excite in the Souls of thoſe that have been in Sieges or Engagements by Sea or Land.

Phyſicians likewiſe meet with many ſuch Inſtances in their Practice. Thus we ſee Women that are troubled with Hyſterical Fits oftentimes upon the ſhutting of a Door, the falling of a Book, or any other unexpected Sound, very much diſturb'd and frighten'd, ſo as to ſtart or leap at it.

I have met with ſome, that being troubled with this grievous Diſtemper, are not only in a continual Fright, but complain very often, that they fancy they hear the Common Voices of Men juſt as if they were the ſhrill Sounds of a Great Bell continually ringing in their Ears, which made them ready to faint.

CON-

CONTEMPLATION XIV.

Of the Senſes of Taſting, Smelling and Feeling.

SECT. I. *Of the Neceſſity of the Taſt.*

NOW as the great Creator is wonderfully Wiſe and Gracious in adapting us to the Senſes of Seeing and Hearing, he is not leſs ſo in the Manner by which he makes our Meat and Drink, the two neceſſary Supports of a decaying Life, ſo agreeable to us.

It ſeems very unreaſonable and improbable, that any Body ſhould be negligent in the ſeaſonable Uſe of Food; but, unleſs it had alſo pleaſed the Goodneſs and Loving Kindneſs of our adorable Creator, to beſtow upon us the Senſe of *Taſting*, and thereby to render the trouble of Eating and Drinking grateful and pleaſing to us, there ſeemed a Danger that many People would have conſider'd it as a Burden and Slavery, and would therefore have often let it alone, at leaſt, they would not have uſed it in due Time or Quantity. And this will not appear ſtrange to any Body that has ever obſerved with how much Averſion, and many times with Loathing too, we are brought to the uſe of Medicines, which, with reſpect to the neceſſity of 'em, do far exceed Food itſelf.

Sect. II. *The Seat of Taſting is in the Mouth.*

Now can any Man think that it happen'd without the Wiſdom of the Creator, that the Senſe of Taſting ſhould be juſt placed in the Mouth, in which all Food is at firſt received, maſticated, or made ſmall by Chewing, and moiſten'd with Spittle, and no where elſe?

Sect. III. *Several Notions about the Inſtrument of Taſting.*

But, in how great Darkneſs the Ancients were, with reſpect to the true Inſtruments by which this Senſe of Taſting is performed in us, and how doubtfully and variouſly even the Modern Enquirers have writ concerning them, may be learned from the Letter of *Malpighi de Linguâ*; ſome placing the true Inſtrument of Taſt in the upper Membrane of the Tongue; others in the ſpungy Membrane thereof; others again in the Nerves that are ſpread throughout the whole Tongue; ſome in the Almond-Glands, and their extended Membranes; others in the Throat; a few in the Pallate, which laſt have been entirely confuted a few Years ago, by the Learned *Bohnius*, *Circul. Anat.* p. 375. At preſent moſt People place them in thoſe little Protuberances, which they call the *Papillæ* or *Nipples*.

Sect. IV. *The Inſtruments of Taſt.*

We ſhall not let ourſelves farther into this Matter, which perhaps may be hereafter cleared up by more Experiments, but only ſay, that the laſt of the above-mention'd Opinions is eſteemed the trueſt, by the greateſt Enquirers into Nature among

among the Moderns. We ſee then, that the Structure of the little Nipples appear peculiar in the Tongue above other Parts, and that they have ſuch a ſingular Form, as ſeems to be required for one of the external Senſes: ſince it is probable, that in the Tegument of the Tongue, theſe Orifices were expreſly made in order to admit into them the Particles of Food moiſten'd by the Glands, and to convey them to the *Papillæ* that lye thereunder, whereby they are affected with that Senſation which we call *Taſt.*

For which purpoſe the accurate Diſſections of the above-mention'd *Malpighi* and others, have ſhewn, that the Nerves of the Fifth and the Ninth Pair, which are held to be the Nerves of Taſting, are inſerted in theſe *Papillæ* after a particular manner, and ſeem chiefly to form this whole Nerve and Papillous Body; accordingly (as it is likewiſe obſerved by the ſame *Malpighius de Linguâ* p. 16.) we find, that the Nerves that are adapted to one of the external Senſes, are at laſt dilated into a flat and membranous Body.

SECT. V, and VI. *Experiments to ſhew that the Taſt is in the Palate.*

THE famous Enquirer into the Secrets of Nature, *Malpighi*, has diſcover'd *Papillæ* or Nipples in the Palate, or Roof of the Mouth, and in the Cheeks alſo; ſo that according to his Hypotheſis, the Palate being likewiſe provided with the true Inſtruments of Taſt, muſt neceſſarily have that Senſation alſo.

To this we may add, that the latter Writings of the Profeſſors *Bergerus* and *Hoffmanus*, publiſhed ſince the Year 1700. do alſo poſſitively aſcribe the Taſt to the Palate, affirming, that *Pliny* in his Natural

Hiſtory has done the ſame; but they are particularly induced thereto by the afore-mention'd Obſervations of *Malpighi*; and farther, by the account we have in the third Year of the *German Ephimerides*, of a Child of about 8 or 9 Years old, in lower *Poictou*, who in the Small-Pox loſt his whole Tongue by a Gangreen, and Spit it out by Piece-meals; inſomuch, that at laſt there did not remain any Sign that he had a Tongue. Notwithſtanding which, this Child did not only Speak, Spit, Chew and Swallow his Victuals, but could likewiſe Taſt, by the remaining Structure of his Mouth; and (as the Author, who was a Surgeon of *Saumur*, ſays *ch.* 8.) he could diſtinguiſh all kinds of Taſts very well; from whence the Writer farther infers from *Pliny*, that the Taſt muſt alſo belong to the Palate.

But ſince this is a thing in which Experience, as in all others, ought to be the Judge, and as the tryal hereof may be eaſily made; Let a Man only take a little powder'd Sugar, Syrup, or any other Sweet Matter, and lay it upon the Tongue; and as ſoon as ever they are melted he will begin to Taſt; probably, becauſe they then begin to penetrate and ſink into the Orifices of the upper Tegument of the Tongue, with the moiſture of the Spittle, and ſo irritate the Nervous *Papillæ* that lye under the ſame.

But if he he proceed farther, and endeavour to ſwallow the ſweet Matter when tis melted, and to that End, preſſes it with the Tongue againſt the hinder Part of the Palate, he will plainly find, that that Part is likewiſe affected with the Sweetneſs; and eſpecially, if after ſuch Swallowing, he preſently draws the Tongue back again to the Palate, keeping it down in ſuch a manner that it cannot touch the ſame, he will find, that when afterwards the Taſt of the Sugar does act upon the Tongue

Tongue a little more sensibly, the Palate will be also more sensibly affected with it for a time. From whence, at least, of how little moment soever this Experiment is, all those disagreeing Notions seem to be over-thrown, and the Opinion, that the Sense of Tasting is likewise in the Palate, is established upon them.

Sect. VII. *The Instruments of Smelling.*

Now to pass on to the Sense of Smelling; Can any one without acknowledging the Wisdom and Goodness of God, observe, that whereas the Bone of the Head is otherwise so hard, the Nerves of Smelling have a Bone to themselves, which, in order to afford them a Passage, is full of little Holes like a Sieve, and which is therefore called the *Spongy* or *Sieve-like* Bone; Thro' which the said Nerves transmit their little Threads and Branches (being there encompassed by the *Dura-Mater*) to the Papillous Membrane or Flesh, as some call it, which lines the Cavities that are in this Spongey-Bone, and in the top of the Nostrils, and which Nerves are expanded therein, in order probably to compose the Instrument of Smelling? For that this Instrument, which produces Smelling, is not below, but at the top of the Nostrils, appears from hence; that in order to Smell, a drawing in of the Breath is necessary, whereby the Particles of the Olfactory Matter being mingled with Air, must strike with some Force against the Papillous Tegument, to produce the Sense of Smelling: And every one that holds his Breath, tho' never so little, can easily experience, that tho' any Smell be brought under his Nose, yet he is not affected with it, till he draws in his Breath again.

This Experiment seemed indeed too trifling and too well known to be mention'd here; were it not that

that a certain Learned and Ingenious Author had denied the ſame. From whence again, as above, in the Buſineſs of Taſting, the Weakneſs of all that is Humane does but too eaſily appear.

Sect. VIII. *Convictions from the foregoing Obſervations.*

Now, can any one that is endued with Reaſon deny the wiſe Diſpoſitions of theſe Inſtruments, namely, that ſince the Olfactory Particles are conveyʼd by the Air, the Inſtruments of Smelling are to be found exactly in the Place throʼ which the Air continually paſſes and repaſſes on the account of Reſpiration? That they are placed juſt over the Mouth to communicate to us, at the firſt, by this Senſe of Smelling, ſome Knowledge of the Qualities of Meat and Drink which we are about to uſe? That the Noſtrils are broader at the Bottom, that they may receive ſo much more of the Olfactory Particles; but narrower at the Top, to the End, that by the Compreſſion of thoſe Particles, the Olfactory Membrane and Nerves may be the more powerfully affected therewith?

Sect. IX. *The Senſe of Feeling.*

Besides the forgoing Senſes, the Inſtruments of which are all diſpoſed in their proper Places, there is one more, which is called the *Feeling*, which is in a manner diſtributed throughout the whole Body, eſpecially, if we underſtand thereby the Senſation of Pain: But if we do not extend it any farther than to that Power or Faculty by which, when we touch any Bodies without us, we are enabled to diſcover the Roughneſs or Smoothneſs, the Solidity or Fluidity, and other Qualities thereof, we can only then ſuppoſe the Seat of this Senſe to be

in

in the Skin. Accordingly, we know that this latter is diſtinguiſhed in the Latin Tongue by the Word *Tactus*, or Touching; and that when we would mention the Senſation of Pain, we expreſs it by the Word *Senſus*, and not *Tactus Dolaris*.

Sect. X. *The Inſtruments of Feeling.*

Now that this laſt, that is to ſay the Touch, is only ſeated in the Skin, which is naked and expoſed to the Objects that are without us, is ſufficiently known to the Modern Anatomiſts; as alſo, that there is in the Skin a Diſpoſition and Contexture analogous to that of the Tongue, which the diligent *Malpighi* and others, find to conſiſt (beſides the Blood and other Veſſels) of Glands, each of which has a little Receptacle or Hole that is open externally, and affords a Paſſage to the Sweat and Perſpiration: From whence it comes, that there ariſe outwardly from the ſaid Skin little Pyramidal Protuberances, like Nipples, which are encompaſſed and faſten'd together by a Reti-formous Body lying betwen the *Cutis* and the *Cuticula*.

Theſe *Papillæ* or Nipples, are what have been of late Years, and with great Appearance of Truth, accounted the Inſtruments of Feeling, becauſe the Microſcopes ſeem to inform us that they ſpring from the Nerves, the Branches of which are inſerted very thick in the Skin, and are more numerous in Proportion, than thoſe that run to the Muſcles or any other Parts, as the great Deſcriber of Nerves, *Vieuſſens*, has ſhewn in his Preface concerning them. It is likewiſe plain from hence, by the help of the Microſcope, that theſe Papillous Protuberances make the upper Skin

riſe

riſe in many Places, to the End, that it may be ſo much the more eaſily affected by the Contract of External Bodies.

SECT. XI. *Convictions from the foregoing Obſervations.*

How uſeful now this Senſe of Feeling is to Mankind in numberleſs Caſes is ſufficiently known; and the more, becauſe every one that wants it, is in many Accidents diſabled from preventing his Ruin; as has been found in one, who having loſt the Senſe of Feeling, together with Motion, on one ſide of the Body, and ſetting too cloſe to the Fire, was miſerably Burnt before he was in the leaſt aware of it. Can then an *Atheiſt* ſay, that he is not bound to be very thankful for ſo great a Benefit as this Faculty is, whereby he is immediately made ſenſible of any violent Heat, and conſequently enabled to avoid the ſame and many other Inconveniencies? Or will he ſay, that it is a ſimple and ignorant Cauſe that has beſtowed this Senſe of Feeling not only upon one Man, but likewiſe upon all, and fixed it not in one only, but in all the Parts of the external Skin.

SECT. XII. *The Fingers and Palms of the Hand have a more accute Senſe of Feeling than other Parts of the Body.*

Is it without Deſign, that in thoſe Parts in which we explore and feel external Objects, this Senſe is much more fine and tender than in thoſe which we ſeldom uſe for that Purpoſe; for it is known to every one, that a Man feels more accurately with the hollow or Palm of the Hand, or the Tips or extream Parts of the Fingers, than in moſt other Places?

And

And this is one of thoſe Reaſons from whence it is inferr'd, that this Papillous Body which lies between the Skin and the upper Membrane is the real Inſtrument of Feeling: Since it appears by experience (according to the Teſtimony of *Malpighi*, and after him of *Bohnius*, *Bergerus*, and others) that in thoſe places, namely, the Palm of the Hand and the Tops of the Fingers, which above other Parts are particularly uſeful in Feeling, there is likewiſe a greater Collection of theſe *Papillæ* or Protuberances, than in the other Parts of the Body, which are not ſo frequently uſed for that purpoſe. It is likewiſe obſerved by *Bergerus*, that theſe *Papillæ* are much more numerous, as well as large, at the Tip of the Tongue, and in the Lips; and that theſe Parts do feel more accurately, as it is neceſſary they ſhould, to the end, that they may immediately diſcover when the Food is too warm or prejudicial any other ways.

SECT. XIII. *Convictions from what has been ſaid above, concerning all the External Senſes.*

WE do now here intreat all ſuch as ſtill ſeem to doubt of the Wiſdom, Goodneſs and Power of their great Creator, yea, even the moſt unfortunate and obdurate Atheiſts, in caſe they can or will receive any kind of Inſtruction, that they would ſeriouſly conſider with us this wonderful Diſpoſition and Structure of the Senſes, and the vaſt Advantages accruing thereby, not only to one, but even to all Men who are in Health: And then let 'em ſay, whether they can ſtill maintain with a good Conſcience, that the Greatneſs and Goodneſs of Him that formed them, does not ſhine out as brightly, yea, and more too in all theſe things, than the skill of an Artificer in the Conſtruction of any curious Machine.

When

When he conſiders that the Smell and the Taſt do likewiſe ſerve to inform us not only of the good and bad Qualities of our Food, but that the Pleaſure which we find thereby excited in us, is an inducement to undergo this daily and continual labour and trouble of Eating and Drinking; will he ſay, that this happens by Chance, and that he is not at all indebted to Providence for all this? That is to ſay, for ſuch noble Exhalations and Perfumes that proceed from ſo many Plants, Herbs, Flowers, Gums, Spices, and other Things; for ſuch a variety of agreeable Taſts, which he daily enjoys from all thoſe Eatables and Drinkables that ſerve for Food and Refreſhment to us.

When he ſees that ſeveral Parts belonging to our Bodies, ſuch as Bones, Nails, Hair, Teeth, ſo far as they are naked, have no Senſation in them; and yet our whole Body is encompaſs'd externally with a Covering and Skin which has the Faculty of making known to, and informing us of every thing that does ſenſibly approach and touch it. Can he think ſuch a Structure as this is brought about without any wiſe Deſign, and will not any intelligent Perſon think it unconceivable?

When he conſiders, that the great Wonder of the Sight enables him to contemplate the Sun, the Moon, and even thoſe Stars that are at an unconceiveable Diſtance from him; and that this Senſe is adapted to an Enquiry into the Magnitude and Motion of ſuch glorious Creatures, and to remark their Laws and Properties; that this Senſe of Seeing can impart to him the Knowledge of many things that are out of the reach of all the other Senſes; that its Inſtruments are of ſo wonderful a Structure as has been already ſhewn: That to the end, that nothing may be wanting to render this Senſe compleatly uſeful, the incommenſurable ſpace of the Heavens is every where filled with

Light;

Light: And particularly, that this Senſation ſhould not be produced in Men without Pleaſure and Agreeableneſs, the unconceivable number of Rays of Light is divided into ſo many kinds, either of Figure or Motion, to repreſent to us all viſible Objects with the moſt pleaſing Colours. Can he ſtill fancy, that there is no Deſign or Contrivance in all this; and that ſuch a wonderful Order and Regularity of every thing, with reſpect to each other, whereby the Light is thus adapted to the Eye, and the Eye to the Light, are all of 'em the reſult of Cauſes working together without Order, and without Underſtanding? Let him once again ask himſelf theſe Queſtions in his moſt ſerious Retirement.

The rather, if he obſerves, that the Hearing informs us of the Motion and Percuſſion of Bodies; of which we oftentimes can get no Knowledge by other Senſes; no, not even by the Sight: That therefore, ſince the Light does only cauſe us to ſee ſuch Objects as are before us, the Rays of it only moving in Right Lines; the Hearing warns us of things that are round about us, and ſuch as are ſometimes even concealed from the Sight, becauſe Sounds paſs thro' all imaginable Curvities.

Without this Senſe of Hearing, how great would the trouble be in communicating our Thoughts to each other? What Inconveniencies would occur to every one in Learning of Arts and Sciences, in Trade, in Pleading and other Worldly Affairs?

Now let one of the moſt conceited Philoſophers, one of the moſt *Strong Minds*, in his own Opinion, or rather one of the moſt to be lamented Atheiſts, tell us here, in caſe he had always wanted one of his Senſes, for inſtance, that of the Sight, whether, by the help of all his Philoſophy, he could ever have known or learned what a ſort of Sen-

Senſation that was, or how Men are affected with that which we call *Seeing*.

Let him make known to us, ſince the Bodily Inſtruments of all our Senſes are all equally produced by, and do conſiſt of the ſame Bread, Water, and other kinds of Food, how it comes to paſs, that his Hand has not the Faculty of Seeing as well as his Eye; that his Foot does not hear as well as his Ear, altho' the Light and the Air may by made to fall upon thoſe Parts in the ſame Figure and Motion. Can any one think, that their different Forms produce ſuch Senſations? Let him then ſhew us how they do it: Let him examine his Meat and Drink after all imaginable Ways, and tell us the reaſon, why the ſame Bread in the Ears becomes an Inſtrument of Hearing, in the Tongue of Taſting, in the Noſe of Smelling, and in the Skin of Feeling: He muſt reſolve it all into the abſolute Will of that adorable Creator, who is unfathomable in theſe his Ways, and who communicates to our Souls the Knowledge of theſe things in ſo wonderful a Manner. He muſt therefore be ſtark Blind that does not diſcover GOD in all theſe Senſes.

Is there no Deſign or End to be obſerved in all this? Let then an unhappy Atheiſt tell us, if he had a mind to make himſelf or any other Perſon happy, and had the Power to do it, whether he would not endow them with every one of the Faculties that are found in theſe Senſes: And in caſe he could have produced any thing like them, tho' in a much lower degree of Perfection by his Skill and Ingenuity, whether he would not think it a very great wrong done to him, if ſome Body, judging of his Performance, ſhould not, or would not ſee the Wiſdom and Contrivance of the Maker therein. And can he ſtill remain inſenſible of his own Blindneſs, who declines to acknowledge the ſame in ſo

aſtoniſhing

astonishing a Machine, as that of Humane Bodies? The rather, whilst he perceives, that in order to render all our Senses compleat and perfect, *Air*, *Light*, *Plants*, *Living Creatures*, and the whole *Universe* almost, must contribute thereto.

If then the Contemplation of all this cannot induce him to acknowledge his Maker's Goodness, and his own Obligations on these Accounts, with the utmost Gratitude; let him but consider with himself in what a deplorable Condition he would find himself and every thing besides, if Mankind were deprived of these Effects of their Creator's Favour, which appear in all their Senses: And let him for once suppose, that there was a Man who having none of these External Senses, did neither *See*, *Hear*, *Smell*, *Taste*, or *Feel*. Now, tho' a Man were always to live thus, even in good Health, could he sufficiently express the Miseries of such a State? He that rightly weighs it, would he not rather wish to be Dead, or to have never been Born, or even to have been a Stock or Stone, than which he is but little better in such a State? Now if without this Mercy of God, the Misery of every particular Person would have been so great; to what shall we compare that of the vast Number of Men, who together make up all the Nations of the Earth, in case there were to be found upon it no other Creatures, but *Blind*, *Deaf*, *Insensible*, and so forth?

Have we then bestowed upon ourselves these Perfections of the Senses? No certainly. Has then mere Chance been able to do it? By no means; for Chance is disposed to operate as well one way as another; and yet we find, that far the greater Part, yea, all sound People, are born with all these Senses.

Let therefore a miserable Atheist confess, that he is not only ignorant, but that he must likewise

for ever remain ſo, of the manner in which our Senſes are produced, and do operate in us. All of them conſiſt in a Motion and Impreſſion that external Objects make upon us; all of them conſiſt of a Motion and Paſſion of ſome of the Parts of our Body; all of them conſiſt of Inſtruments produced by the ſame Meat and Drink; and according to the beſt Philoſophy, nothing elſe but a Motion of the ſame Matter can be underſtood to reſult from ſuch a Syſtem of Matter.

Whence then proceed the various Conceptions which we find in ourſelves, upon *Seeing*, *Hearing*, *Taſting*, *Smelling* and *Feeling*? Muſt not then the Atheiſt, ſince there can be no other Subterfuge, acknowledge here that there is ſomething Immaterial in us, which is the Cauſe thereof? Let it be ſo: But if it be Incorporeal, how can it be moved by ſomething that is Corporeal? For there is nothing but Bodies and Motions, both in the Matters round about us, and in the Inſtruments themſelves of our Senſes: Will he ſay then, that a Soul cannot be moved becauſe it is Incorporeal? How then does it happen, that a Subſtance, which can neither be moved, nor touched by Bodies, is yet affected by or through the Motion of Bodies; and can *See*, *Hear*, *Taſt*, *Smell* or *Feel*? For that it is ſo in Fact, cannot be denyed.

I think we need not uſe any farther Argument to drive an Atheiſt into a Confeſſion of his total Ignorance. And if he does not know how all theſe things come to paſs, as his own Conſcience muſt convince him that he does not, how can he, if he would be taken but for a tolerably Wiſe Man, pretend to maintain it for a Truth, that a Thing, which he does not know how it happens, can be produced by the neceſſary and ignorant Laws of Nature; Let him reflect upon all theſe things

moſt ſeriouſly with himſelf, before he proceeds any farther.

But if all that we have already ſaid concerning the Senſes, be not ſufficient to convince him, let us go one ſtep farther, and ſhew, that even the Bounds themſelves, within which the extent of the Power of our outward Senſes is confined, do likewiſe contribute to make us more happy, than if they could be extended a great deal farther, as in this laſt Age they are found to do, by the help of Artificial Inſtruments.

Let us ſuppoſe, that our Eyes had the Faculty of our Modern Microſcopes; it is true, that they would ſhew us a World of New Creatures; a drop of Pepper-water, or Vinegar, and the Seminal Matter of Creatures, would appear like Ponds or Rivers full of Fiſh; the Scum of ſtinking and putrified Liquors, like a Field full of Flowers and Plants; the Mites in Cheeſe, like great hairy Spiders, and a thouſand other things in like Proportion; but it may be alſo no leſs eaſily conceived what a Loathing of many Things, which in themſelves are otherwiſe very good and uſeful, theſe Swarms of Inſects would produce in us, which perhaps would be more evident, if you had ſeen as I have, how ſome People viewing the Mites in a piece of Cheeſe thro' a Microſcope, and upon one of theſe exceeding ſmall Creatures falling off, ſuddenly ſnatch'd away their Hands, for fear it ſhould fall upon them, which, by reaſon of the Smalneſs of the Creature, excited a general Laughter in ſome of the Standers by; but in others, more grave Reflections on account of the Wiſdom of God, who has been pleaſed to conceal theſe things from the naked Eye of Ignorant and Fearful People: And yet to bleſs the Diſcoveries of of Men by the Inventions of New Glaſſes, ſo far,

that the neceſſary Means ſhould not be wanting to ſuch as endeavour to look into theſe Wonders.

Moreover, would theſe Philoſophers even dare to deſire, that their own Eyes ſhould be endowed with the Qualities of the beſt Microſcopes in caſe they underſtood the Nature and Foundation thereof? And would they judge themſelves more happy, by ſeeing an Object ſo ſmall in itſelf, magnified to ſo large a Size? When in the mean time all that their Sight could extend itſelf to, would be contained within more narrow Bounds than that of a Grain of Sand; nor would they be able to ſee any Objects plainly and diſtinctly, but ſuch as were at no farther Diſtance from their Eyes, than one or two Inches: And as for all other things that were more remote, ſuch as Men, Beaſts, Trees and Plants, to ſay nothing of the Sun, Moon and Stars, thoſe ſublime Creatures, they would either be entirely inviſible to them, or would appear at leaſt very confuſedly; yea, if all this were ſo, and that the natural Sight could penetrate as far as the fineſt Microſcopes, none that have ever experienced the ſame can deny, but that, by the help of them, one may ſee Bodies compounded of a thouſand little Particles; and conſequently, that in order to ſee every thing truly, and in its original or laſt Parts, the Sight muſt be ſtill extended unconceivably farther than ſuch Microſcopes have yet been able to carry it.

Now, on the other hand, ſuppoſe our Natural Eyes to be great Teleſcopes, like thoſe that have enabled us to obſerve ſo many new Stars in the Heavens, and make ſo many new Diſcoveries in the Sun, Moon and Stars, they would be again liable to this Inconvenience, that they would be of very little uſe in ſeeing the Objects that ſurround us, as they would likewiſe not a little obſtruct the Contemplation of all other Objects upon the Earth, becauſe

becauſe they would ſee too much of the Vapours and Exhalations continually riſing from the Ground, which, like great thick Clouds, would hide every other viſible Matter; as is but too well known to ſuch as uſe theſe Inſtruments.

Thus likewiſe, if the Senſe of *Smelling* ſhould be as acute and nice in Men, as it ſeems to be in ſome kinds of Hunting Dogs; no Perſon, no Creature, could ever meet us; nor could we paſs by any Footſteps of them without being ſtrongly affected with the *Effluvia* that proceed from them; and we ſhould be forced to turn our Attention, tho' never ſo much againſt our Wills; and tho' we ought to apply it to more exalted Objects, I ſay, we ſhould be compelled fix it upon theſe contemptible Matters.

In caſe the *Tongue* ſhould make us Taſte Food of the loweſt with ſavour, as high a Senſation as now the ſtrongeſt and fineſt *Ragouts*, or made Diſhes do produce; there need no farther Proof to induce every one to confeſs, that this alone would ſuffice to render ſuch Food very diſagreeable to us, after having uſed it but a few times.

Could the *Hearing* ſo nicely obſerve all its Sounds, as it is now found to do, when, by the help of the Long Tube, or Speaking Trumpet held to the Ear, any Body Whiſpers ſoftly into the Broad End of it; how little Attention would People have for ſome Things? Certainly no more than we have when we find our ſelves in the midſt of confuſed Noiſe and Bawling of a great many Voices, or the loud Peals of Drums and Guns. They that have ever been witneſs of the Inconveniencies that Sick People undergo by Hearing too acutely, will eaſily be convinced of this Truth.

If the *Feeling* were ſo tender and nice in all the Parts of the Body, as we find it in the moſt ſenſible Places, and in the Membranes of the Eyes;

muſt we not own that we ſhould be very unhappy, and ſuffer a great deal of Pain too, by the touch of the lighteſt Feather?

To conclude; can any Body reflect upon all this, without acknowledging therein the Goodneſs of his Maker, who has not only furniſhed him with ſuch noble Perfections, as are the external Senſes, for want of which, he would not be better than a Stock; but who has likewiſe out of his adorable Wiſdom, included theſe Powers within ſuch Bounds, without which they would have been no other than burdenſome to us, and a perpetual Obſtruction in the attentive Contemplation of greater Matters?

If it ſhould appear to ſome, that we have dwelt longer upon this Subject than is perhaps agreeable to 'em, let them be pleaſed to remember, that our Principal Deſign throughout this whole Work, is to repreſent to *Infidels* and *Atheiſts*, the Wiſdom and Goodneſs of their Creator, which ſhines out ſo brightly in the external Senſes of Men, and the unconceivable Faculties, or Properties thereof.

CON-

CONTEMPLATION XV.

Of the Union of Soul and Body: Of the Imagination and Memory.

SECT. I. *The Union of the Soul and Body unknown to us: Convictions from thence.*

NOW ſince each of theſe External Senſes do lead us up to the Soul; can there likewiſe be any Perſon ſo unhappy, as truly to reflect upon this Wonder, ſurpaſſing the Conception of all the Philoſophers, this moſt aſtoniſhing Manner, after which the Body is united to the Soul, without being thereby convinced of the unexpreſſible Power and Wiſdom of Him that made 'em? Of Him, who has ſhewn himſelf in this, as well as in many other things, after a glorious Manner, both Wonderful and Adorable; who, whilſt He thus Works in Ways unfathomable by all Men, does likewiſe compell even his Enemies to be Witneſſes thereof.

And tho' others may think that they can form any Notions thereof; yet an Atheiſt muſt confeſs, that there is ſomething in it which is perfectly unintelligible to him.

For ſuppoſe he ſhould boldly maintain, that the Corporeal Matter (in which, however, he can ſhew us nothing but Motion) has the Property of Thinking and Underſtanding; let him tell us, and ſhew us, what Compoſition of Parts, what Force, what Swiftneſs, what Limits and Directions of Courſe, either according to right or crooked Lines,

are required in Matter thus moved, to render it capable of Reaſoning and Comprehending a Mathematical Demonſtration. And we ſhall not need to ask him, whether this ſurpaſſes his Underſtanding.

Or, ſuppoſe alſo, that he ſhould, according to Reaſon and Experience, affirm, that his Soul is Incorporeal; let him ſhew us, how it comes to paſs, that a Soul being Immaterial in its Exiſtence, and which, according to all the Notions we are wont to form of it, can neither touch or be touched by a Body, and yet can be affected *by*, or *through*, or *according* to the Motion of the Body (for we ſhall not here diſpute about the manner of it, that being not neceſſary with reſpect to Atheiſts) and *vice verſâ*, the Soul can affect and move the Body, or at leaſt adminiſter Occaſion thereto, which, for the foregoing Reaſons, we need not now examine: So that by its mere Will, the Body being in good Health, the ſtretching out the Hand, for inſtance, immediately follows; and if that Hand ſhould be burnt, the Soul imemdiately feels Pain. Now if all this were not as certainly known to him, as the moſt certain thing in the World is, foraſmuch as he can be every minute convinced thereof, by repeated Experiments, would not he be tempted to look upon ſo diſagreeing Notions, and which have not the leaſt Analogy to one another, as groſs Falſhoods and vain Conceptions of the Brain? Wherefore, whatever an Atheiſt may fancy to himſelf, the manner of the Union of the Soul and Body muſt always remain unconceivable and unintelligible to him.

I know very well, in caſe we proceed no farther, that the great Diſagreement, concerning the manner in which the Body is moved by the Will, and which has occaſion'd many Treatiſes among Great and Wiſe Men, muſt be left undetermined by

by us: But neither is this the Place, nor yet the Time, to ſay any thing about it, ſince we only write for the Conviction of Atheiſts; whereas the others, howmuch ſoever they differ in their Opinions, do all agree in the Belief of a GOD.

SECT. II. *The Bounds of this Union.*

THIS Union of the Soul and Body is not only wonderful in itſelf, and in the manner in which it happens, but likewiſe in the Bounds and Limits which are preſcribed to it. We find it thus, in the firſt Place, that *the Soul does not operate by its Will* (however it be) *upon our whole Body*; or rather, *that our whole Body is not ſubject to the Soul in its Motions*, but only, as it ſhould ſeem, thoſe Parts that receive their Nerves from the *Cerebellum* and Back-Bone: Wherefore it is only our Arms, Hands, Legs, and all thoſe Members with which we are ſaid to act freely, that are moved according to the Pleaſure of the Soul; whilſt other Parts, which have their Nerves from the *Cerebrum*, and which do only ſerve for Life and the Support thereof, as the *Heart*, the *Arteries*, the *Stomach*, the *Bowels*, &c. do by no means obey the Will of the Soul, nor, like the former, can be moved or ſtopt at Pleaſure.

Secondly, *Neither does the Soul feel when every Part of the Body is acted upon or affected.* Thus we find, that beſides the *Hair* and *Nails*, the *Bones* themſelves are likewiſe inſenſible; all which make up a great Part of our Body: Not to mention that the *Lungs* are known to waſte away in many Men without Pain; and that the Chirurgical Obſervations teach us, that the Subſtance of the *Brain* may ſuffer very much, without communicating any Senſation thereof to the Soul.

SECT.

Sect. III. *Convictions from them.*

Can now a deplorable Atheiſt think he has ſo much cauſe to accuſe the Chriſtians of Credulity, when he hears them make the following Concluſion from the above-mention'd Premiſes: That ſince no Body can juſtly aſcribe all this to mere Chance, working indifferently one way as well as another, this is a true and convincing Proof that it can by no means proceed from a neceſſary Series of Laws of Nature, always operating after one and the ſame manner, that the Soul ſhould have the aforeſaid Relation or Reſpect to the Body. Foraſmuch as the Wiſe Creator being deſirous to convince us all, that He neither operates by Chance, nor is confined and determined by certain neceſſary Laws, but freely, and according to his own good Pleaſure, has render'd ſome Parts of the Body obedient to the Will of the Soul; and cauſed others to move entirely independent thereupon; nevertheleſs, theſe laſt as well as the firſt are ſo far ſubjected to the Soul, at leaſt related to it, that both the one and the other, ſo long as the Soul remains united to the Body, but no longer, are enabled to perform their Functions, and remain without Corruption.

And that Atheiſt that will hearken to Reaſon, ſeems particularly to be obliged to juſtifie a Chriſtian in the aforeſaid Concluſion, ſince it is just thoſe Parts that ſerve for the ſupport of our Life, ſuch as the *Heart*, *Stomach*, and other *Entrails*, that are not only, not ſubmitted to our Will, but moved unknown to it, by the Power of the Great Creator, that he may convince us of our Dependance upon him. Whereas, on the contrary, the Motion of ſuch Members as the *Tongue*, *Hands*, and the reſt, are left to the Diſpoſition of our Will,

Will, that they may ſerve to Acknowledge and Glorify our Great Benefactor, likewiſe in our Bodies, which is what He with ſo much Juſtice requires of us.

Sect. IV. *The Imagination and Memory.*

There would yet have been ſomething ſtill wanting to the Perfection of a Humane Creature, notwithſtanding this wonderful Union of the Soul and Body, if we could not have exerciſed the Underſtanding and other Faculties of our Souls upon ſuch Objects only as are preſent or before us. Nor would our Judgments and Inferences or Deductions have been of much weight, if we could not have compared preſent Things with any other paſt or future.

How ſhould we have been able, for inſtance, to have made any uſeful Diſcoveries about the Laws of the Sun's Motion, in caſe nothing thereof were known to us beſides what we could learn from things preſent? For as to thoſe that are abſent, ſuch as things paſt or to come; the external Senſes, tho' they be the firſt Helps of Enquiring into all Bodily Matters, cannot inform us the leaſt thereof. Even the Hearing itſelf, which ſeems otherwiſe to be in ſome meaſure adapted thereto, would yet be entirely unfit and uſeleſs to this Purpoſe, without the other Powers, of which we are now about to Treat.

Our Gracious Creator, in order to multiply his Wonders upon us, and to render us compleatly Happy, has been pleaſed to ſupply this Defect likewiſe, and to lodge in us a Power of repreſenting to the Underſtanding, even paſt, future, and all abſent Things. The firſt of theſe Faculties is named by the Philoſophers, the *Memory*; the laſt, the *Imagination*.

Whether

Whether it be now that theſe owe their Origin to certain Motions of the *Spirits* or *Humours*, or *Membranes*, produced by our external *Senſes* or *Thoughts*, and leaving behind them Traces and Footſteps in the *Brain*, which give our Souls an occaſion to think after ſuch a manner, as if the things repreſented to the Imagination or Memory, were really preſent: Or whether there be any other cauſe thereof; this is certainly true, that the endowing Mankind with ſuch a Power, does far exceed the very wiſeſt Diſcoveries. And in caſe we were not aſſured thereof by Experience, who could believe that it was poſſible for any Man to repreſent to himſelf things having no Exiſtence, as if they were Exiſting; Dead things as Living; and thus to render an Object as Preſent, which is either Abſent, or even not Exiſting at all?

CONTEMPLATION XVI.

Of the Humane Paſſions or Inclinations, and briefly of Procreation.

SECT. I. *The Paſſions and Inclinations.*

MAN being thus bountifully furniſhed by the Goodneſs of his Creator with all the above-mentioned Powers and Faculties, ſeemed to be placed upon the higheſt degree of Happineſs. His intelligible *Soul*, united after ſo wonderful a manner to his *Body*, exerts its Conceptions and Judgment upon all Matters that occur to it; his external *Senſes* impart to him the Knowledge of material Beings; his *Imagination* and *Memory* repreſent to him every thing

thing that is abſent, either paſt or to come; his *Heart* and *Arteries* beat; his *Bowels*, and all his other Parts that are neceſſary to Life do, by the Power of his Creator, continually diſcharge their Functions, without giving him the leaſt trouble during the whole Courſe of his Life; the other Limbs and Members are obedient to his Will, enabling him to glorify his Maker with Thankfulneſs, and be uſeful to himſelf and his fellow Creatures.

Now this laſt might ſeem to be in ſome manner inconvenient to him, it being the only Motion that can occaſion Trouble or Wearineſs to him. But to the End, that he ſhould not faint nor be diſcouraged whilſt he is promoting his own Happineſs, or that of others, who are dear to him; it has pleaſed the ſame Gracious GOD, not only to enable all the Powers of Man to be concurring thereto, but which is a greater and particular Benefit, to be concurring therein with Pleaſure; and accordingly, to endow him with various Inclinations and Paſſions to ſtir him up to perform, with Zeal and Eagerneſs, all that is neceſſary for him to do.

Thus we find in ourſelves a Deſire or *Longing* and *Hope* for that Good which we conſider as approaching to us; and *Joy*, when we have obtained it, and *Love* towards it, when we are poſſeſſed of it: And on the contrary, a *Fear* for approaching Evil; a *Sorrow* when it comes upon us; and *Hate* againſt the Cauſes that make it keep the Poſſeſſion of us. Now, not to give a Liſt of their Names here; Can any Man contrive or invent ſharper Spurs to induce him to ſeek after that which he eſteems good to himſelf, and thoſe that are dear to him, and to avoid all that he thinks Evil? And how ſtrongly a Man can be excited thereby, daily Experience teaches us; as well

well as the deplorable Examples of thoſe unhap-
py Men, who by a corrupt Judgment, embracing
Good for Evil, and Evil for Good, make a wrong
uſe of theſe ſo neceſſary Paſſions.

Now to repeat our Queſtion again, Can theſe
Incitements and Allurements be lodged in us by
mere Chance, or any thing that has neither Know-
ledge nor Underſtanding? Which, in order to
render us more happy, do not only induce us to per-
form our Actions with ſo much Eagernſs, but
do likewiſe, upon many occaſions, and even
without our Will, give the Inſtruments of our Mo-
tions more Life and Energy; or, have not here all
reaſonable Men juſt cauſe of Thankfulneſs for the
Mercies of their Creator, who, conſidering us as
the Maſter-piece of all his Works, would not ſuf-
fer us to want thoſe Powers, whereby we are en-
abled to promote the Welfare both of ourſelves and
fellow Creatures, even with Pleaſure and Satis-
faction.

Sect. II. *The Difference of Paſſions and In-clinations.*

And if any one ſhould fancy that this Queſtion
ſuppoſed too much, in order to demonſtrate, that
the Wiſdom and Goodneſs of the Creator only,
and no accidental or ignorant Cauſes, has any
Place in theſe Paſſions: Let him reflect upon these
two or three following things only with us; from
whence the Government of God, and the Execu-
tion of his wiſe Purpoſes, ſeem to ſhine out ſo
brightly, that even an Infidel, or any other that
doubts of it, if he would but uſe his Reaſon, can-
not with any Foundation, inſiſt upon a fuller Proof
thereof.

For

For were there no GOD that directed every thing according to his Providence; how comes it to paſs that Men (whoſe Bodies and all the Humours thereof are made out of the ſame Food, and therefore conſiſt of the ſame Matter) do yet, in caſes where the Intereſt of Humane Society requires, differ ſo much from one another, in their Paſſions and Inclinations; inſomuch, that each of 'em do with Pleaſure embrace ſome particular Buſineſs (with a view to their own Eaſe and Advantage) in order to pleaſe and profit their Fellow Creatures?

Now ſince no Man's Life is long enough, nor no Body's Opportunity or Power great enough to provide every thing for himſelf neceſſary to his Support and well Being; Can we not herein diſcover a Providential Direction, to render Men Aſſiſting and Helpful to each other in their particular Wants, that each one, out of Choice and Inclination, is driven on, even, tho' his own Gain be chiefly in view, to concur, as far as in him lies, thereto? Thus it happens in our Fancies to particular Studies; one finds himſelf inclined to that of Divinity; another to the Knowledge of Laws and Cuſtoms; a third to Phyſick; a fourth to an Enquiry into the Nature and Works of God; others, to the reading of the Tranſactions and Revolutions that have happen'd to the World in former Ages, in order to apply that Knowledge to the Prudent Conduct of Affairs in their own Time. Many again find themſelves inclined to quite other Sorts of Employments; ſuch as don't ſo much care for a Speculative Life, take more pleaſure in Trades and Merchandizing, which likewiſe they make Choice of according to their different Paſſions and Humours. Others betake themſelves to the ſeveral Arts of Painting, Building, and to Manufactures,

Manufactures, of which likewiſe the kinds are both Different and Numerous.

Can any Body now judge, that it is the reſult of mere Chance, that Men, from all of whom, by reaſon of the Similitude of their Structure and Food, one ſhould ſeem to expect nothing but an Identity of Inclinations, do diſcharge their Affairs and Functions ſo variouſly? And as ſtrange as this may appear to every one at the firſt view, yet does not Experience teach us, that 'tis of abſolute neceſſity to all Mankind that it ſhould be thus? And in caſe all of them were inclined to the ſame thing, for inſtance, if every Scholar ſhould apply himſelf to the ſame Studies, every Merchant deal in the ſame Wares, every Artificer in the ſame Handicraft, there would not only be a Failure, but likewiſe an entire Deprivation of the Eaſe and Convenience of the whole World.

Sect. III. *The Agreement of the Inclinations and Paſſions.*

Against all this, a miſerable Philoſopher that apprehends nothing more than to be forced to acknowledge a Supreme Director of all Things, and conſequently to meet with an undoubted Puniſhment for his Blaſphemy and Atheiſtical Behaviour, would endeavour to object this Subterfuge and Evaſion, namely, that we are taught by Experience, that ſuch a great Difference of Paſſions are innate, and brought into the World with all Men; and therefore, that they only flow from the particular Contexture of Bodies, *&c.*

But to convince theſe Perſons that this, and every thing beſides, is rather the effect of a wiſe Direction, than of mere Chance or ignorant Laws of Nature; let them go a little farther with us and ask themſelves the following Queſtion; In caſe

caſe this variety of Paſſions does proceed only from the Structure of Men, how comes it, that the contrary has place where the diverſity of Inclinations would be hurtful to the Publick? Why have all Men living one and the ſame Deſire to eat their Food with Pleaſure? Why are all Men, and even all other Living Creatures, hurried on with the ſame, and ſometimes ungovernable Paſſions, to Generation or Procreation? And laſtly; Why have they the ſame Love to their Children?

Certainly no Body will deny that unleſs theſe Paſſions were found to be alike in all Men, and in caſe there were room here for ſo great a Diſagreement as in the others; or, to carry on the ſame Compariſon, if the Deſire towards Food were only found in a few Perſons, Food itſelf would be no otherways uſed by many, than as a Medicine againſt that Death which was to be the Conſequence of an unſatisfied Hunger. Now, with how much Averſion and Loathing this happens in many, even where the Diſtemper renders it moſt neceſſary, is ſufficiently known, and from thence as eaſily infer'd, that many People, abſtaining too long from the uſe of Food, loſe the Powers and Faculties of Digeſtion. If likewiſe there were as few inclinable to Generation, as we ſee there are, who chooſe the ſame way of Living and Employments, muſt it not be confeſſed that the World would be ſoon Naked and Diſpeopled? Again, if the Love of Parents to their Children were ſo uncommon, as the Inclination of Men to one and the ſame Trade or Calling, how many poor Creatures juſt born, would for want of Neceſſaries, meet the End of their Lives almoſt as ſoon as the Beginning?

And to conclude the whole with one word, Let an obdurate Atheiſt put this Queſtion to himſelf, and Anſwer if he can: Whether he does not

therein diſcover the Wiſdom of a Great Director? And whether he can, with an entire Conviction, and without being contradicted by his own Conſcience, affirm, that it appears to him to be merely accidental, that there is found a variety of Inclinations in Men, where ſuch a variety is uſeful to Mankind; and on the contrary, that the Inclinations and Paſſions are there only uniform where ſuch a Uniformity is neceſſary; and where a Diſagreement would Diſpeople and Deſolate the whole Earth? At leaſt, let him tell us, whether, if he were to have regulated theſe things for the good of the World, and with the utmoſt Prudence he could have fallen upon a better Method?

Sect. IV. *The Love of our Country.*

What neceſſity can be deduced from any natural and ignorant Cauſe, from whence it ſhould follow, that all Men feel ſuch an over-ruling Inclination towards the Country in which they are born? And how is it poſſible, that the cold, barren, Northern Parts of the World, where beſides, a great Part of the Winter is nothing but a diſmal Darkneſs, ſhould not yet be Diſpeopled of their Inhabitants; or, that they ſhould not yet have betaken themſelves to the fine Southern Countries, where the Air is milder, and all the Neceſſaries and Refreſhments of Life more plentiful, long before now; and, which is more, that many Men after having taſted the Pleaſure of the latter, ſhall yet freely return to the former: I ſay, how can this be accounted for, without reſolving it into the Will of the Great Director, that Men ſhould likewiſe inhabit even ſuch Parts of this Globe?

Sect.

Sect. V. *The Contempt of Dangers.*

If this be not ſufficient to convince our Atheiſt, let him conſider in the laſt Place, whether he can, upon his Principles, account for that dreadful Thirſt after Honour and Glory, which all Ages have beheld with Amazement, in the Actions of their Heroes; and which hurries Men on, and makes them run headlong into the greateſt Dangers, yea, even Death itſelf, to which Humane Nature has the greateſt Averſion.

Not to mention thoſe whom their Wants oblige to follow the War, can any one reflect, without wondering, that Great Men and Illuſtrious Perſons (who are otherwiſe in a Condition to enjoy all the Pleaſure of the World in Plenty, and at leaſt, to die an eaſie Death in a good Old Age) ſhould yet expoſe themſelves with ſo much Zeal and Bravery to the innumerable Dangers of War, where they daily, and by a terrible Experience, find that Lot to fall to others, which to Morrow, or perhaps ſooner, may be theirs; alſo of being ſlain, or at leaſt render'd miſerable all the reſt of their Lives, by their Wounds and Loſs of their Limbs.

Now, to aſcribe the Cauſe of ſuch a noble Courage and Bravery to mere Chance, is a very ungrateful and unworthy Treatment of thoſe great Men, whoſe Wiſdom has not given the World leſs matter of Admiration, than their Courage.

To deduce it from Stronger Paſſions, is likewiſe not poſſible, as we have already ſhown, becauſe the fear of Death, provided that they may live without Shame or Miſery, is the ſtrongeſt of Paſſions in all Men whatſoever. What Reaſon then can be thought of for all this, ſave only the Supreme Will of the great Directer of all things? Who has infuſed into the Souls of ſome Men,

whom his Providence has marked out for great Events, the right Principles of a true Generoſity and Courage; letting them ſee that he has choſe them out of an infinite number of other Perſons, and laid this Obligation upon them of oppoſing Tyranny and Abſolute Power, and of reſtoring to their own Country, and to their Friends and Allies, thoſe deareſt Bleſſings of Religion and Liberty, even at the hazard of their own Lives. And who again has made others, tho' they propoſed to themſelves no other End than the gratifying their own Inclinations, or at leaſt, acquiring Riches and Glory, like many of the Heathens, to deſpiſe Death and Danger in a moſt unconceivable manner; whereby he he has compelled them, tho' inſenſible thereof, to be ſubſervient to his Providence and Adorable Purpoſes.

Sect. VI. *Convictions from the foregoing Obſervations.*

Let him that has hitherto doubted of God's Government, ſeriouſly reflect upon this Great Wonder, and ſee whether he can deduce that which he finds true by Experience, of the Courſe of theſe Paſſions and Inclinations in Mankind, from an accidental Concurrence of *Nerves* or *Fibres*, or *Humours* of the *Body*; or from any Laws of a ſtupid Nature, unable to propoſe to itſelf the leaſt Deſign in all its Works; And then tell us how it can come to paſs, that upon ſuch Principles, theſe Functions ſo neceſſary and uſeful to humane Kind, and at the ſame time ſo wonderful too, can be ſo conſtantly diſcharged; and that in all Ages the ſame Steadineſs and Uniformity has appeared therein, which can never be applied or attributed to mere Chance?

Sect.

Sect. VII. *The Deſire of Procreation.*

Can any Body avoid ſeeing from all that has been ſaid, that the Inclinations inherent in Mens Minds, as corrupt as they be, and applied often to wrong Objects, owe their Origin to ſomething more that Humane Wiſdom? Which having thought fit to render them ſubſervient to his great Purpoſes, cauſes them to prevail over all Obſtructions; to which end, he has vouchſafed to qualifie the moſt Bitter things, which in their own Nature can produce nothing but Averſion and Terror with the moſt deſirable Charms, and to render them, as I may ſay, Palatable, with an agreeable Sauce to incline our Paſſions thereto, notwithſtanding all the aforeſaid Impediments; and to the end, that we may put this paſt all doubt, let the Atheiſt, beſides what we have juſt now ſaid, about the Contempt of Dangers; let him, I ſay, turn his Eyes with us upon that Inclination which Men feel in themſelves towards Procreation.

Now if it were not the Will of the great Director of all Things, that the Race of Men, which would otherwiſe end in each Individual, and be quite extinct with the Life of one Man only, ſhould be ſupported in their Poſterity; How happens it that all Living Creatures are hurried thereto with a Paſſion exceeding all others? But to proceed farther, How is it conceivable, when in the bearing and bringing forth of Children, Women do not only undergo ſo much Trouble and Pain, but frequently viſible Danger of Death, that there ſhould be one only to be found, that would venture the ſame a Second time after having once made the terrible Experiment? I ſay, how comes all this to paſs, if it had not pleaſed the great Creator to

confirm the Words which he ſpoke in the beginning of the World, *Gen.* i. 28. *Be fruitful, and multiply, and repleniſh the Earth.* And thus to ſupport the Truth of them by a never-failing Experience. In vain do we ſeek for other Reaſons thereof, nor can any thing ſeem more unreaſonable than to aſcribe this to Chance or ignorant Cauſes, eſpecially if we weigh the following Circumſtances: Can any one imagine, that it is without Deſign, that there ſhould be made juſt two ſorts of Perſons in every thing alike to each other, and different only in thoſe Parts that are required for Generation; and that, beſides theſe two, we know well enough, that there was never any third?

SECT. VIII. *Why we have not treated more fully and minutely upon the Buſineſs of Generation.*

WHOEVER reads this will perhaps think it ſtrange that we have not ſpoken more largely concerning the Affair of Procreation, ſince the Providence, Wiſdom and Power of the great Creator ſhines forth ſo irreſiſtably and glaringly in that whole Matter. But they may be pleaſed to know, that the ſame Reaſons that made us keep ſilence, or ſpeak ſparingly upon many other of the foregoing Subjects, ſuch as the manner after which the Separation of the Humours is made, the Tumifaction or ſwelling of the Muſcles, the Uſes of the external Senſes, the Limits of the ſo called *Senſorium Commune*, and many more, have induced us likewiſe to obſerve the ſame Caution here; *viz.* becauſe the Truth has not yet been confirmed by Experiments in ſo ſure a manner, but that there ſtill remain a great Variety and Difference in Opinions among the moſt learned Men concerning them.

SECT.

SECT. IX. *The Principles or* Stamina, *or Living Creatures.*

WHETHER it be then, that the firſt Principle, or *Stamen*, of Men is to be ſought for among the *Animalcula*, or among other Particles without Life indeed, but put into Motion (for thus differently are they defined by ſome of the moſt famous Enquirers into Nature) which, by the help of Microſcopes are diſcover'd *in Semine Maſculino*, of all Creatures that have been hitherto examined: Whether it be to be found in the Eggs of the Females, as others pretend; or laſtly, whether it be that the Coition of both the Sexes is neceſſarily required to the Formation of this *Stamen*; all which we do not pretend to determine here: This is however ſure enough, and after ſo many Enquiries, is received by all the Modern Philoſophers, that all Living Creatures whatever proceed from a *Stamen* or Principle, in which the Limbs and Members of the Body are folded and wound up as it were in a Ball of Thread; which by the Operation of Adventitious Matter and Humours are fill'd up and unfolded, till the Structure of all the Parts have the Magnitude of a full grown Body. In order to be convinced thereof, the Reader may conſult the Obſervations of the great *Harvey*, both upon Men and Beaſts, both the *Viviparous*, or ſuch as bring forth their Young alive, and the *Oviparous*, or thoſe that lay Eggs, in his Book *de Generatione Animalium*. And after him the accurate *Malpighi*, in the Experiments he makes upon the Hatching of an Egg, and the Formation of a Chicken in the Egg.

Thus we find the firſt of thoſe ſpeaking of it in his 15*th* Exercitation; *That the Stamen, to the beſt of his Knowledge, before he had obſerved it, was accounted by no Body to be the firſt Origin of the Chicken.*

And *Malpighi* ſpeaks of it in the following manner; *Wherefore it muſt be owned that the Stamen of a Chicken is already in the Egg before the Hatching; and therefore muſt have proceeded from a Higher Cauſe after the ſame manner, as in the Eggs of Plants.* Thus he makes an entire Analogy between the *Stamina* of Living Creatures and the Seeds of Plants: In which laſt he is likewiſe wont, for the ſame Reaſon, to mention ſome Parts by the Name of the *Uterus*, *Placenta*, and the like, which are only proper to Living Creatures.

It ſhall ſuffice here, to have quoted thoſe two great Men for the Confirmation of the Truth of what has been before-mention'd, ſince they ſeem to have been the firſt Diſcoverers thereof: And ſince all the Great Naturaliſts of this Age have been convinced thereby, and by their own further Experiments, that the Beginning of all Creatures conſiſt in a *Stamen*, as may be ſhewn in numberleſs Places of their Writings, which thoſe that pleaſe may have recourſe to.

I would have been ſomething more particular upon this Subject here, which ſeems to be the proper Place for handling it: But foraſmuch as the encreaſe and growth of Animals from theſe little *Stamina*, may receive a great Light from thoſe of Plants, which may be found in every Seed; I chuſe rather to refer my Reader to *Contemplation* XXIII. where I expreſly treat of that Subject; or rather to the *Obſervations* upon *Plants*, of thoſe famous Philoſophers Meſſieurs *Grew* and *Malpighi*, where he may find Experiments enough, to ſhew that a Plant is produced from a *Stamen*, and a living Creature from a like *Stamen*; or, to ſpeak in their uſual Language, is unfolded, as we ſee in a Silk-worm, where the Butterfly comes out of the *Aurelia*, in which laſt all the Parts of the Butterfly are involved or roll'd up. *See Malpighi de Bombyce.*

And

And ſince we have already an Experimental Certainty, that a Male and Female Creature are neceſſary toward the Procreation of another of the like Species; I leave it to thoſe that have the Opportunity of carrying their Enquiries farther, what is performed by each of 'em in particular, towards Generation; as likewiſe, whether in the Egg of a Female, the ſolid Parts of the *Stamen* of the future Creature are to be found; and whether it be impregnated and vivifyed by the *Semen Maſculinum*, and brought into Motion agreeable to the Laws of the Seminal Matter.

This ſeems to have acquired ſome degree of Probality; foraſmuch as we know that the Body of a Man does not only conſiſt of Solid and Fluid Parts, but is likewiſe endowed with certain Laws, purſuant to which all the Parts are moved; ſo that thereby the ſame Bread, which at firſt according to the Laws to which 'twas Subject in the Plant, was Wheat or Rye, being afterwards eaten by a Pullet, does, according to other Laws, become Pullets Fleſh, and finally this Pullet being again Converted into Humane Food, becomes the Fleſh of a Man: and ſo in other Caſes.

This might cauſe ſome Suſpicions, whether that which is diſcover'd by the help of a Microſcope in *Semine Maſculino* (which the accurate *Verheyen*, *Part* II. *p.* 69. aſſerts to be Particles put in Motion, and not the *Stamina* of Living Creatures) may not be that Matter, which, according to the Laws that the great Creator of all Things has produced in every particular Man and Beaſt, being put into Motion (and like Fire that kindles other Matters, or Yeaſt that ferments other Liquors, and moves them according to its own Laws) does propagate and maintain the Laws of the required Motions in other Subſtances: Whereupon the Obſervation of Mr. *Hartſoker*, as related by

by the ſaid *Verheyen*, are very remarkable; it appearing thereby, that this mov'd Matter in *Semine Maſculino*, does preſerve its Motion ſome Hours in the Cold, but in the Heat it ſoon diſappears. This ſeems better to agree with Particles that evaporate with Warmth, than with *Animalcula*, which uſually ſtand in need of it, and are firſt produced by Warmth; at leaſt, if we ſuppoſe theſe Particles to be diveſted of Animal Life, and to be only Matter put into Motion, this abſurd Conſequence may be prevented, namely, that in the *Semine Maſculino* of every Creature, there muſt be a thouſand loſt for one that comes to good.

Experience does likewiſe ſeem to confirm the ſaid Hypotheſis (that from the Female proceeds the Matter, and from the Male the Particles that propagate the Laws of Motion therein) foraſmuch as a Mule is produced from the Coition of a Horſe and an Aſs; and ſo in other Mixtures of different Species. The above-mention'd Mr. *Verheyen*, *p.* 71. may be conſulted hereupon. But this may ſuffice for Probabilities, ſince, as far as I know, no Body has yet been able to give us an entire Deciſion of this Matter.

Sect. X. *Convictions from the foregoing Obſervations.*

Only foraſmuch as it is now found to be experimentally true in almoſt all kinds of Plants and Living Creatures, that have been enquired into, that the former have their Origin in a Seed, and the latter in *Stamina*; but none from meer accidental Cauſes, as Corruption and the like, I cannot upon this occaſion forbear entreating the unhappy Atheiſt, if any Convictions will yet ſatisfy him, that he would be pleaſed ſeriouſly to reflect on all theſe things by himſelf, and then pronounce

nounce, whether mere Chance, or other Cauſes ignorant of what they did, when they thus acted, could produce all theſe *Stamina* of Men (not to mention here the Seeds of Plants and Eggs of other Creatures) with ſo much Art and in ſo great a Number; and could inſert and fold up all the Limbs and Joints of ſuch a wonderful Machine, as is the Humane Body, in ſo nice and accurate a manner, that the ſame ſhould be fill'd up and nouriſhed by Juices, or (to uſe the common Technical Word) having expanded or infolded it, would bring this Body into ſuch a Diſpoſition and Structure as is neceſſary for ſo many great Purpoſes for which it is formed.

The Atheiſt cannot be ignorant how many Learned Men have openly acknowledged in their Writings, the Almighty Power of the great Creator, upon enquiring into theſe his wonderful Works and Productions of Men, Beaſts and Plants from ſuch ſeeming inconſiderable and contemptible *Stamina*. Now then one of theſe two things muſt be true; either that it is a certain and undeniable Demonſtration of a GOD; or that ſo many famous Men, are utterly ignorant wherein the Strength of ſuch a Proof conſiſts, and are therefore to be accounted compleat *Viſionaries* or Whimſters, if not mere Fools. This laſt muſt be aſſerted by the Atheiſt concerning moſt of the famous Undertakings of the late Age, or elſe he muſt abandon his unhappy Principles: Let him therefore conſider with himſelf, for what he himſelf muſt paſs, with all Rational and Equitable Perſons.

SECT.

Sect. XI. *Several Difficulties removed.*

Now that a *Stamen*, which perhaps at firſt contained nothing more than the Quantity of a little Grain of Sand, and perhaps leſs, can be unfolded or expanded to the Magnitude of a Humane Body of Six Foot long, a Mathematician will freely, and even an Atheiſt himſelf, if he underſtands any thing of the Mathematicks, muſt confeſs. But foraſmuch as others, and even ſome well-meaning Chriſtians, cannot eaſily conceive this great Expanſion of ſuch a ſmall *Stamen*, and may therefore think it impoſſible, it ſeems proper and uſeful too, to remove this Difficulty, by ſhewing the poſſibility thereof.

Let it therefore be ſuppoſed ;

I. That the Divine Power can divide a determinate Quantity of Matter (for inſtance, a little Grain of Sand, or any thing leſs) into ſo many Parts, and more than any Man can expreſs by a definite Number. No Body can deny this ; and even an Atheiſt muſt acknowledge, that in reſpect to this Grain of Sand, ſuch a Diviſion or Separation of Parts does neither include a Contradiction, nor any Impoſſibility in itſelf.

II. That a Foot being divided into ten Parts, each of thoſe Parts may contain a hundred Grains of Sand ; which many other do admit with us.

III. That the Body of a Man which is Six Foot high, may be ſuppoſed to contain in it Six Cubical Feet ; which, allowing for the Cavities therein, may be a pretty juſt Calculation.

VI. Now ſince 100 Sands do compoſe the tenth Part of a Foot in length, which we will here call an Inch, and ten ſuch Inches in a Foot, a thouſand Sands will go to the length of one Foot ; and conſequently (ſuppoſing for convenience

ſake

ſake, the Sands to be ſo many little Cubes 1,000,000,000 or (to expreſs this Number with more Brevity, or the Unite with nine Cyphers) 10^9 Sands do compoſe one Cubical Foot, which being multiplied by Six, makes the whole number of Sands, that may be contained in a Humane Body of Six Foot in length, amount to 6,000,000,000, or 60^9; from whence it appears, that in caſe ſuch a Stamen, no bigger than a ſmall Grain of Sand, were divided into 6,000,400,000, of Parts, in each ſpace of a Sand in this Body one Particle of the ſaid Sand might be placed.

V. Now to proceed further, ſince it appears from the XXVI. *Contemplation*, §. 16. of Mr. *Leuwenhoek*, that ....1 of the length of a Sand, is the utmoſt that can be diſtinguiſhed by a Microſcope; to the end, that we may not take any Quantity that may not be juſtly ſuſpected of not being diſtinctly Viſible; let us take the ....1 of this length; ſo then ....1 of a Sands length is incapable of being diſtinctly viewed by any Microſcope. Since then there go 10^8 of ſuch Particles into the Compoſition of one Sand, there will be 6027 of ſuch little Cubical Spaces in a Humane Body of Six Foot in length; but by reaſon of their Smallneſs, they will be undiſtinguiſhable, even with the beſt Microſcopes.

Now if we ſuppoſe that in each of theſe ſmall Spaces, there be a Million of Parts in one Sand, there will go to the Compoſition of the aforemention'd Body 60^{33} of the like Particles of Sand.

VI. Now in caſe the *Stamen* of a Man, which we have ſuppoſed to be as big as a ſingle Grain of Sand, were divided into ſo many, or into 60^{33} Parts; its Parts may be ſo diſpoſed and expanded, that in each ſmall Space of a Humane Body of Six Foot in length (which Parts, by reaſon of their Smallneſs, have not yet been able to be diſtinguiſhed

guished by the finest Microscope) there may be contained a Million of such Particles of Sand. And since the Interstices between the Particles of the *Stamen* are yet so much smaller than the aforesaid little Spaces, they will be yet less visible thro' a Microscope, and consequently almost invisible to the naked Eye; certainly in no manner distinguishable.

VII. And thus it appears to be possible, that such a small *Stamen*, no bigger than a Sand, may be expanded and brought to the Analogous Composition of a Humane Body of Six Foot long; which Body, in its whole Matter, did not contain more than the quantity of this single Sand, yet in such a manner, that there was not one visible Place therein so small, in which there were not contained more than a Million of Particles of this little *Stamen*: Between all which Particles, there were still remaining so many Interstices or Vacuities, that this Body, which, by reason of its Lightness, might be deemed little more than a Shadow, can be so filled with flowing and adventitious Parts fixing themselves in these Interstices, and Cloathing as it were the Parts of this *Stamen*, that it at last attains to the Weight and Size of a Common Body of a full grown Man.

VIII. And to the end, that no Body may be surprised at these minute Divisions of the quantity of a Grain of Sand, he will find in *Professor Keil's Introduction, p.* 55. something that may appear much more wonderful to him, of which however, the Possibility is there demonstrated; *viz.* how not only a Body of Six Foot in length, but even that unmeasurable Space, containing in its Circumference the Starry Heavens; or even a much larger, if you please, may be filled and obscured by the Dust of one single Grain of Sand, after such a manner, that not so much as a Ray of Light, tho' never so fine, shall be able to pass between the

the Parts of that Sand: Imagine then how far this ſurpaſſes all that we have ſuppoſed to happen in a Humane Body.

IX. To prove this by a like Experiment, we ſhall ſhow in our CONTEMPLATION upon *Light*, that a Particle of the Tallow of a Candle, not exceeding the quantity of a ſingle Grain of Sand, is really and actually divided into many more than the aforeſaid 60^{11} Parts.

To demonſtrate this very briefly here, you will find in the juſt now mention'd Contemplation, that a Cubical Inch of Candle-Tallow, does emit or yield the Number of $26961704o^{11}$ Parts of Light. Now, according to *Numb.* IV. here above, there are 1000,000 Sands in the quantity of ſuch a Cubical Inch, and conſequently there proceed from a Particle of Tallow, of the bigneſs of one Sand, $26961704o^{11}$ Parts of Light.

And according to *Numb.* VI. the Stamen that was likewiſe of the ſize of a Sand, was ſuppoſed to be divided into 60^{11} Parts.

By which number of the like Particles, which proceed from the quantity of a Sand, or are divided into $26961704o^{11}$ Parts, there will proceed 44936173 with a little Fraction. From whence it appears, that each little Particle of this Stamen, how ſmall ſoever it may be (to take a round number) may be ſtill divided into 44, and very near 45 Millions of Parts; before each of them arrive to the Smallneſs of one of the Particles of Light, that continually flows from a Burning-Candle.

Now that theſe exceeding ſmall Particles are not unneceſſary, on account of their Smallneſs, but are made uſe of to great Purpoſes in the Univerſe, ſhall be hereafter Demonſtrated in our 25th *Contemplation*; as it is manifeſt from thoſe of Fire, which are found every where in the viſible World,

and

and are made uſe of by the great Governour thereof, for ſuch wonderful as well as terrible Ends.

And thus will it appear plain enough, as I think, that in ſuch Expanſion and Diviſion of this *Stamen*, we do not come near to that minuteneſs, into which we ſee experimentally that other Bodies in the World may be divided.

Sect. XII. *Convictions from the foregoing Obſervations.*

We do not here pretend to determine the manner that God has been pleaſed to make uſe of in the Expanſion of his Created *Stamina*; we muſt leave that to his infinite Wiſdom, whoſe Ways, herein eſpecially, are inſcrutable, or paſt finding out; nor have we had any other view in what we have ſaid concerning it in the foregoing *Section*, than to convince the Atheiſts, that they had a Maker, and to ſet things in a ſomewhat clearer Light before the Eyes of ſuch Chriſtians that are not juſt accuſtom'd to compute theſe Matters after the manner of Mathematical Propoſitions; and therefore might find ſome Difficulty in expanding ſuch a Small *Stamen* to the ſimilar State of a full grown Body.

Let then an unhappy Philoſopher, who will not yet confeſs an All-ruling God, from what has been ſaid before; Let him, I ſay, retire to ſome ſolitary place, and ſeriouſly comtemplate his own Body, and then judge, whether it could poſſibly come to paſs without a wiſe Direction, that from ſo ſmall and tender a *Stamen*, expanded, filled or ſtuffed out and cloathed with other Matter, a Body ſo wonderfully formed and adapted to ſo many Uſes in all the Limbs and Parts, has been produced. What is there in a Watch, and in the adjuſting of all its Wheels, Springs, *&c.* that can be

be compared to the wonderful Formation of a Humane Body? And yet, was ever any Body ſo Senſeleſs, or to ſpeak in ſofter Terms, ſo deplorably Unhappy, that he ſhould dare to maintain, in the preſence of Underſtanding Perſons, that the Watch which he carries in his Pocket, was framed in that manner, without any Wiſdom or Deſign.

Sect. XIII. *Tranſition to a Demonſtration againſt Chance.*

But as little as we know touching the manner of the Production of Humane kind; yet in what we daily ſee thereof (tho' ſcarce obſerved by any) there is a very remarkable and ſtrong Proof of a Divine Providence, adapting all things to its wiſe Purpoſes, and a plain Demonſtration, that the World is by no means governed by Chance.

Before I propoſe it, I find my ſelf obliged to acquaint my Reader, that the Diſcovery thereof is owing to the Ingenuity of Dr. *Arbuthnot*, a famous Mathematician, Member of the Royal Society, and Phyſician in Ordinary to the late Queen of *England*, who has been ſo kind as to tranſmit it to me thro' the Hands of Mr. *Burnet*, the worthy Son of the late Biſhop of *Salisbury*, ſo famous and ſo well known to the Learned World; the which Mr. *Burnet* is likewiſe himſelf a great Mathematician, and Fellow of the ſaid Society, and has allowed me the Honour to adorn this Treatiſe therewith.

SECT. XIV. *A Table of the Number of Males and Females Christen'd yearly in* London *in* 82 *Years.*

Ann.	Males.	Females.	Ann.	Males.	Females.
1629	5218	4683	1670	6278	5719
30	4858	4457	71	6449	6061
31	4422	4102	72	6443	
32	4994	4590	73	6073	6120
33	6158	4839	74	6113	5821
34	5035	4820	75	6058	5738
35	5016	4928	76	6552	5717
36	4917	4605	77	6423	5847
37	4703	4457	78	6568	6203
38	5359	4952	79	6247	6033
39	5366	4784	80	6548	6041
40	5518	5332	81	6822	6299
41	5470	5200	82	6909	6533
42	5460	4910	83	7577	6744
43	4793	4617	84	7575	7158
44	4107	3997	85	7484	7127
45	4047	3919	86	7575	7246
46	3768	3995	87	7737	7119
47	3796	3536	88	7487	7101
48	3363	3181	89	7604	7167
49	3079	2746	90	7909	7302
50	2890	2722	91	7662	7392
51	3231	2840	92	7602	7316
52	3220	2908	93	7676	7483
53	3196	2959	94	6985	6647
54	3441	3179	95	7263	6713
55	3655	3349	96	7632	7229
56	3668	3382	97	8062	7767
57	3396	3289	98	8426	7626
58	3157	3018	99	7911	7452
59	3209	2781	1700	7578	7061
60	3724	3247	1	8102	7514
61	4748	4107	2	8031	7656
62	5216	4803	3	7765	7683
63	5411	4881	4	6113	5738
64	6041	5681	5	8366	7779
65	5114	4858	6	7952	7417
66	4678	4319	7	8379	7687
67	5616	5322	8	8239	7623
68	6073	5560	9	7840	7380
69	6506	5829	10	7640	7288

In this Table it is remarkable:

I. That at *London*, in these 82 following Years, the number of Males has exceeded that of Females every Year.

II. That the Difference thereof has always lain between two Terms, not far from one another. So that,

III. There were always more Males born than the half the Children amounted to in one Year. And,

IV. That the Number of the Males never exceeded that of the Females so far, that almost all the Children should be Males.

Sect. XV. *A Judgment upon the said Table.*

Now, forasmuch as by Sea and Land Fights, by other dangerous Occasions, and especially by a more irregular way of Life among the *Men*, a much greater number of them do daily Perish than of the *Women*, by such Distempers that are peculiar to them; can it be thought that it happens without a particular Direction of Providence, that there are constantly more *Men* born than *Women*?

And (which is wonderful) that there are but just so many more, that there still remains for every *Woman* a *Man* of her own Age, in her own Country, and of equal Condition to her; This is confirmed by a perpetual Experience, to the Satisfaction of every one that makes use of his Reason.

From whence Dr. *Arbuthnot* observes, that it seems to be plainly deduced, that *Poligamy*, or the marrying of more Wives than one, is as opposite to Nature, to the Government of the World, and the common Interest of Mankind, as it is contrary to the particular Laws of every Country; because if one Man has several Wives, so many other Men

muſt remain without them; beſides that it ſhould ſeem that many Women cannot be ſo well impregnated by one, as each Woman by her own Husband.

Sect. XVI. *The firſt Mathematical Demonſtration that the World is not governed by Chance.*

But to come finally to the chiefeſt Proof that may be drawn from hence, againſt an Accidental Cauſe; ſince Dr. *Arbuthnot*'s Buſineſs would not allow him to follow this Table in all its Particulars, and from thence to form a Calculation (which, according to the common manner, would have required the continual Labour of ſeveral Months, as is well known to thoſe that are vers'd in the Computations of the Games of *Chance* or *Hazard*) he he therefore ſuppoſes for Convenience ſake:

I. That if an equal number of Pieces of Money were thrown up into the Air, the Chance of their falling *Croſs* or *Pile*, as it is commonly called, would be equal; ſo likewiſe among any equal number of ſo many Children, there would be juſt as many *Males* as *Females* born in the World if thoſe Births happen'd by meer Chance.

II. This Gentleman ſhews, that if a Perſon (whom we ſhall call A) ſhould have laid the Wager D, that in toſſing up ſome thouſand Pieces of Money, there would have fallen as many Croſs as Pile, the ſaid A would have had a very ſmall Chance of winning his Wager D; and that the value of his Chance would have been much leſs than $\frac{1}{2}$ of D.

III. But becauſe the former Suppoſition, that the Number of *Males* and *Females* is yearly equal, does too much leſſen the Chance of A, that lays ſuch a Wager; Dr. *Arbuthnot* does again advance that in order to make good ſuch Diminution, the Chance of A (which is otherwiſe ſhewn to be of much

much leſs value than $\frac{1}{2}$ the Wager of D, every Year, or every Time) is now really ſo much greater, and its value is compleatly $\frac{1}{2}$ of D.

VI. This being now laid down, if a Perſon (whoſe Chance is $\frac{1}{2}$ of D) ſhould wager that ſuch a thing ſhould happen 82 times to one; or rather, that there ſhould be as many *Females* as *Males* born every Year for 82 Years together; as he had wager'd before, that there ſhould be ſo in one Year; they who underſtand the Computations of Hazard or Chance, know that his Chance will be be as $\frac{1}{2}$ eighty-two times multiplied into itſelf, and afterwards with D; or that there is ſo great a Number (as is required when the double Number of 82 times multiplyed by itſelf, and the Unit ſubſtracted from it) againſt One; that the ſame ſhould not come to paſs by Chance after this manner, 82 times together: Which therefore makes a Number of 25 Numerical Figures following each other, the firſt five whereof are 48357; as may be proved by the Logarithms with very little trouble. They that would know it more exactly, may compute it farther by the ſaid Logarithms; or elſe multiply the double Number 82 times by itſelf, and ſubſtract the Unit.

Now in caſe it is ſo many againſt one, that this ſhould not happen in *London* 82 Years together; let any one experienc'd in Calculations conſider, how great a number there will be againſt one that the ſame thing don't happen throughout the whole World, and ſo often in 82 Years following; and then let him judge, whether it can be believed that Chance has any place here: For that this has really happen'd many Ages together, and in all Places of the World, may be maintained with great Probability, becauſe, that in all Times, and in all Places, the *Men* are expoſed to more Dangers than the *Women*; and nevertheleſs there

will be found in all Countries *Men* for *Women*, and *Women* for *Men*, of equal Age and Condition.

SECT. XVII. *The Difficulties and Objections that ſome may make againſt theſe Calculations anſwer'd.*

THUS far Dr. *Arbuthnot*, whoſe Brief Remarks upon what has happen'd, according to this Table, is ſo ſtrong a Proof of a wiſe Government of the World, that the ſame ought fully to ſatisfie every one who underſtands this Calculation. But ſince ſome Atheiſts, willing to evade the Force of this Argument, might ſtart the following Objection; That Dr. *Arbuthnot*, to avoid trouble, ſuppoſes the Chance of one who lays a Wager, that ſuch a thing ſhould happen in one Year to be as $\frac{1}{2}$ D; which does not agree juſt literally with the Table; let them know, that the ſole Miſtake that can be ſaid to be made therein, is only this; That this Gentleman allows too much to thoſe that aſſert a Chance in theſe Matters, by ſuppoſing the Odds to be $\frac{1}{2}$ D; and that therefore the Number, that according to his Hypotheſis ſtands againſt One, is much ſmaller than would be produced upon theſe Grounds by a more accurate Computation, in caſe he could have allowed the neceſſary time for making it. This is obvious to all that underſtand this Computation, ſince, allowing his Adverſary the half of the Chances, he will win if there be only more Pieces of Money falling Croſs or Pile, or more Males than Females born, without any Limitation when the number of the Pieces, or of the Children is unequal; and in an equal number of Pieces, or of Children, the Adverſary would over and above have for himſelf the half of all thoſe Chances which an equal Number of Croſs and Pile, or an equal Number of Males and Females, ſhould give: Whereas, according to the

Table

Table (by reaſon of the Limitations, between which the Majority of Males is really found) a great many Chances, in which there are more Males than Females, would make them loſe; as alſo all the Chances which an equal Number of both would produce: Which does not want to be Demonſtrated for ſuch as are only experienced in the beginning of theſe Calculations. I thought it my Duty to add this, in order to clear the ſaid Calculation, which indeed is ſtrong enough, but was however framed with a Deſign of not ſpending too much Time upon it, from all the Objections of ſuch as pretend to cavil at it.

And all that we have here ſaid, *viz.* that Dr. *Arbuthnot*, to avoid the Trouble and Time that ſo nice a Calculation would have required, has granted his Adverſaries much more than was neceſſary; may viſibly appear from the Calculation, which that moſt ingenious Mathematician, Mr. *'Sgraveſande* (Profeſſor of Mathematicks at *Leyden*) has been pleas'd, after a particular manner, to make upon it; by which the uſual Method neceſſarily required in the Diſcuſſion of this Matter, and in which a vaſt deal of Pains and Time is taken up, is extreamly abridged.

Sect. XVIII. *A ſecond, and more accurate Mathematical Demonſtration, that the World is not govern'd by Chance.*

This Gentleman therefore reſolving not to confine himſelf to any particular Hypotheſis, and with a cloſer view to the Numbers of the Table itſelf, in order to diſcover that Number ſtanding againſt One, that what happen'd in *London* in the above-mention'd 82 Years, would not have happen'd if it had been the mere reſult of Fortuitious Cauſes

Cauſes, adds up all the Children born in theſe 82 Years, in one Sum together, and finds that the 82d Part thereof amounts to 11429; which Number is therefore the Medium or Middle Number, which, in caſe there were ſo many Born yearly, would again produce in 82 Years the ſame Number of Children as the Table contains in its Total.

Finding moreover in the Table, that in the Year 1703, the Difference between Males and Females, in proportion to the Number of Children, was the ſmalleſt; and that in the ſaid Year there were but 15448 born in all, of which 7765 were Males, and 7683 Females, he takes the middle Number to be 11429; and according to this Calculation he ſuppoſes there to be 5745 Males, and 5684 Females.

In like manner obſerving, that in the Year 1661 the Difference between Males and Females was greateſt, if calculated again according the aforeſaid middle Number 11429; the Males of that Year will come out 6128, and the Females 5301.

The firſt Queſtion then which is here to be anſwer'd, may be propoſed after the following Manner:

A wagers with B, that if 11429 Pieces of Money be thrown up in the Air, there will not fall down of 'em fewer than 5745 Croſs, nor more than 6128; or thus; that among 11429 Children, born every year according to this Medium, there will not be fewer Males than 5745, nor more Females than 6128.

The Queſtion then is, concerning the value of the Chance of A? Or rather, how many Chances there be againſt One, that what A has wager'd ſhall not come to paſs, if all things depend on Fortune?

Sect. XIX. *The Calculation after the common Manner.*

To return an Anſwer to this Queſtion, let it be ſuppoſed that C ſignifies Croſs, and P Pile, or Males and Females, then they who underſtand the Modern Calculation of the Games of Hazard, know,

I. That the *Binome* C P, or M F, muſt be raiſed to the Power of which the *Exponent* is 11429, or the ſaid Sum of 11429 muſt be multiply'd by itſelf.

II. That all the *Co-efficients* or *Genitures* of the Terms taken together, or the Power of the two Numbers, whereof 11429 is the *Exponent*, yield the quantity of all the Chances that can happen concerning the ſaid 11429 Pieces of Money. We will call the ſame $p+q$.

III. That all the *Co efficients* as well of both the Terms, in which we find $k^{6118}\ m^{5311}$, and $k^{5745}\ m^{5684}$, as of all the Terms that are between theſe two, being added up together, make up the number of all the Chances which will cauſe A to win. We will call it p.

IV. That all the other poſſible Chances, except thoſe which cauſe A to win, are to the Advantage of B, and theſe we will call q.

V. Wherefore if D be put in, that the value of the Chance of A, is $\frac{p}{p+q}$ D, when A has wager'd or laid that it ſhall happen once, in the Money thrown up, or with the Children in one Year.

VI. And therefore the Chance of the Wager laid by A, that it ſhall ſo happen, againſt that of B, who has laid the contrary (ſuppoſing it all mere Hazard) is as p^{11429} to $p^{11429}+q^{11429}-p^{11429}$, or, to make uſe of the Unit, according as it is expreſt in the former Queſtion;

Queſtion; as 1 to $\frac{p+q^{82}}{p^{82}} - 1$, that is, as the Unit, to a Number which is found by dividing the quantity of all the poſſible Chances $p+q$ by p; or by the quantity of all thoſe that cauſe A to win, and ſubſtracting the Unit from this Quotient multipliy'd 82 times by itſelf.

Sect. XX. *This Tedious Calculation contracted.*

All this, as we have ſaid above, is well known to ſuch as are vers'd in the Computations of the Chances of Games, but it is however very certain, that as ſhort and eaſie as the Solution of this Queſtion appears to be in Words and Algebraical Letters, yet the nimbleſt Arithmetician, conſidering the greatneſs of the Numbers that are to be found, would want ſome Months to diſpatch it, if he would expreſs it properly by Numbers, and would alſo be ſatisfyed, that there were no Miſtakes in his Calculation. Wherefore the aforemention'd Mr. *'Sgraveſande*, according to his vaſt Experience and Skill in Mathematics, has remarkably abridged this Matter, and cut off the much larger Part of the tedious Work, which the common Method naturally requires, ſhewing demonſtratively, and with incomparably leſs Pains, that the *Ratio* of the Chance of A to that of B, found in the foregoing *Section*, as 1 to $\frac{p+q^{82}}{p^{82}} - 1$ (not only with the requiſite Exactneſs, but even the cauſing ſeveral very ſmall Fractions, which would otherwiſe have been neglected, to tend to the Advantage of A, and thereby not to be liable to any Contradiction) I ſay, that the ſaid *Ratio* may be expreſt by the *Ratio* of the Unit to a Number, which reſults or is found by the multiplying 1191816836776356273376 eighty two times by each other, and ſubſtracting the Unit.

Unit. So that with very little trouble, and by the help of the *Logarithms*, we may ſee that there is a Chance of 44 Figures (of which the firſt five are 75598) againſt One, that what happen'd in *London* in the ſaid 82 Years, would not have happen'd, if it had been directed by Hazard only.

Mr. *'Sgraveſande*, who has computed the ſame by Logarithmical Tables, finds it to be, 75, 598, 215, 229, 552, 469, 135, 802, 469, 135, 802, 469, 469, 135, 802, 469, againſt One.

Sect. XXI. *Convictions from the foregoing Calculations.*

Now let every Man that can repreſent to himſelf the greatneſs of this Number, judge whether it is a wiſe Direction, or Fortune and Hazard only, that take place in this Matter; the rather, if he conſiders how much greater this Number or Sum would be, if the ſame thing happen not only at *London*, but throughout the whole World, which for the Reaſons already alledg'd, is very probable.

This is certain, that ſince this Sum is greater than all the Grains of Sand, which ſome Millions of Globes, like that of the Earth, can contain, he that thinks it credible that what happen'd at *London* fell out by pure Chance, muſt likewiſe maintain, that he thinks it as probable, that a Perſon deprived of his Sight and Feeling, and who has no manner of Rule for the Direction of his Hand, and therefore muſt abandon himſelf entirely to Chance, ſhould ſingle out one particular Grain of Sand out of ſuch an unconceivable Heap jumbled all together, the very firſt time he ſhould put his Hand into it.

Sect. XXII. *Expreſſion of the Number found in Common Words.*

Before I quit this Subject, ſince there be among theſe Philoſophers who aſcribe all things to mere Chance, ſome alſo that are not uſed to extend their Speculations to Arithmetic, or Numbers, and to whom the Common Expreſſions of *Billions*, *Trillions*, and the like are unintelligible, and conſequently make no Impreſſion on them; it may not perhaps be unprofitable, in order to give them a more convincing Conception of the Number diſcover'd by Mr. *'Sgraveſande*, §. XIX. to expreſs the Greatneſs thereof in ſuch Words as every Body underſtands.

For which Purpoſe we know that when this Number of 54 Figures is divided by the Unit with 39 Noughts or Cyphers following (§. XIX.) there will remain a Dividend of 75598, and a Fraction beſides. From whence it follows, that if we multiply a Number of *a Hundred Thouſand times a Hundred Thouſand Millions* firſt with *a Hundred Thouſand times a Hundred Millions*, we muſt take *Ten Millions* of this prodigious Number above *Seventy five Thouſand, five Hundred, and Twenty eight times*, before we can come at the Number or Odds againſt One, that what happen'd at *London* in the aforeſaid *Eighty two Years* would not have ſo happen'd, if the Birth of Males and Females were the reſult of mere Chance only.

The End of the firſt Volume.



THE CONTENTS OF THE Second VOLUME OF Dr. *Nieuwentyt's Contemplations.*

CONTEMPLATION XVII.

Of the Air.

Sect. I. *Transition to the Contemplation of the World.*

Sect. II. *And first of the Air.*

Sect. III. *The Gravity and Elasticity of Air.*

Sect. IV. *An Experiment concerning the Gravity of the Air.*

Sect. V. and VI. *The Air's Elastic Faculty prov'd Experimentally.*

Sect. VII. *The Pressure of the Air.*

Sect.

The CONTENTS.

Sect. VIII. *The Miſtakes of ſome Atheiſts.*

Sect. IX. *A Deſcription of Barometers, &c.*

Sect. X. *A Barometer made of Water and Lee, with ſome Experiments.*

Sect. XI. *The prodigious Preſſure of the Air upon a Man.*

Sect. XII. *Convictions from the foregoing Obſervations.*

Sect. XIII. and XIV. *Other Experiments proving the Preſſure of the Air.*

Sect. XV. *Convictions from the foregoing Obſervations.*

Sect. XVI. *A little Air reſiſts a greater quantity.*

Sect. XVII. *A little Air gravitates as ſtrongly as a great deal of Air.*

Sect. XVIII. *The Difference between the Gravity and Elaſticity of the Air.*

Sect. XIX. *How the Elaſtic Power of the Air works by the Gravity thereof.*

Sect. XX. *The Air that bears moſt weight is moſt compreſs'd.*

Sect. XXI. *Air that is moſt Compreſſed is moſt Elaſtic.*

Sect. XXII. *Convictions from the foregoing Obſervations.*

Sect. XXIII. and XXIV. *The Elaſtic Power of the Air is the Cauſe of Suction, proved Experimentally.*

Sect. XXV. *Convictions from the foregoing Obſervations.*

Sect. XXVI. *Experiments to ſhew that Living Creatures will periſh in a Place from which the Air is exhauſted.*

Sect. XXVII. *Atheiſts deny their own Principles.*

Sect. XXVIII. *To die in an Unelaſtical Air is no neceſſary Conſequence of Nature.*

Sect. XXIX. *To dye therefore in an Air diveſted of its Elaſticity is only the reſult of the Will of GOD.*

Sect. XXX. *The Elaſtic Faculty of the Air is not ſufficient alone for the Preſervation of Life.*

Sect.

Sect. XXXI. *The Elaſtic Power of the Air does likewiſe cauſe Fiſh to live and ſubſiſt under Water.*
Sect. XXXII. *Plants do alſo live by Air.*
Sect. XXXIII. *Fire is ſupported by Air.*
Sect. XXXIV. *Air cauſes Smoak and the Particles thereof to aſcend.*
Sect. XXXV. *Air is the cauſe of Sounds.*
Sect. XXXVI. and XXXVII. *Several Experiments of the Productions of Sounds by Air.*
Sect. XXXVIII. *Convictions from the foregoing Obſervations.*
Sect. XXXIX. *The Uſe of Air in Pumps.*
Sect. XL. *The Air contains fermenting Humours in Veſſels.*
Sect. XLI. *About Refraction and Twilight.*
Sect. XLII. *Convictions from the foregoing Obſervations.*
Sect. XLIII. *The Gravity and Elaſticity of the Air unknown to the Ancients.*

CONTEMPLATION XVIII.

Of Meteors.

Sect. I. *Tranſition to the Meteors.*
Sect. II. *The Air is a Menſtruum or Diſſolving Fluid.*
Sect. III. *The Air is Impregnated with a great variety of Particles.*
Sect. IV. *The ſame proved in Sulphureous Particles.*
Sect. V. *The like Mixture with Particles of Fire.*
Sect. VI. *Alcalis and Acids mix'd with Air.*
Sect. VII. *Burning Spirits and Oyls mix themſelves with the Air.*
Sect. VIII. *Other Particles do likewiſe mix themſelves with the Air.*
Sect. IX. *Many Particles preſerve their Properties in the Air.*

Sect. X. *The aforemention'd different Particles by acting on each other do produce both wholsome and unwholsome Airs.*

Sect. XI. and XII. *Several Experiments proving the same.*

Sect. XIII. *Convictions from the foregoing Observations.*

Sect. XIV. *The Invisibility and Insipidity of the Air is very useful.*

Sect. XV. *The Observation of Meteors resumed.*

Sect. XVI. and XVII. *Mists and Fogs produced by many Exhalations, and by the Rarifaction of the Air prov'd Experimentally.*

Sect. XVIII. *Reflections and Observations upon the same.*

Sect. XIX. *An Experiment to shew that Mists and Fogs may be produced by Effervescences.*

Sect. XX. *An Experiment proving the like Effect by Precipitations or Separations.*

Sect. XXI. *Fogs are Clouds.*

Sect. XXII. *Wind and its Usefulness, and Convictions from thence.*

Sect. XXIII. *The Trade, Winds and Monsoons.*

Sect. XXIV. *Convictions from the foregoing Observations.*

Sect. XXV. *A Brief Description of the above-mention'd Winds.*

Sect. XXIV. *Transition to Experiments about the possible causes of Winds.*

Sect. XXVII. *The First Experiment touching the Contractions of the Space in which the Air is contained.*

Sect. XXVIII. *The Second Experiment with the hollow Globe.*

Sect. XXIX. *The Third Experiment; the moving of solid Bodies by the Air.*

Sect. XXX. *The Fourth Experiment, Effervescences.*

Sect. XXXI. *The Fifth Experiment, by burning Sulphureous Bodies and Salt Peter together.*

Sect.

Sect. XXXII. *The Sixth Experiment, ſhewing that the Elaſtic Power of the Air being augmented, produces Winds.*
Sect. XXXIII. *The Seventh Experiment; the diminution or weakening of the Air will produce the ſame effect.*
Sect. XXXIV. *The Eighth Experiment, of producing Wind by Cold.*
Sect. XXXV. *The Ninth Experiment of Wind produced by Warmth.*
Sect. XXXVI. *The Tenth Experiment; Wind produced by the Suſpenſion or Ceſſation of Warmth.*
Sect. XXXVII. *The Eleventh Experiment, wind produced by the Motion of the Air upwards.*
Sect. XXXVIII. *Convictions from what has been Repreſented about the Air in general.*

CONTEMPLATION XIX.

Of Water.

Sect. I. *Without Water every thing would dye with Thirſt.*
Sect. II. *Convictions from thence.*
Sect. III. *Without Water every living Creature would likewiſe dye with Hunger.*
Sect. IV. *Experiments proving that Plants conſiſt for the moſt part of nothing but Water.*
Sect. V. *It is not here conſider'd, whether Water be a ſimple or compound Body.*
Sect. VI. *Convictions from the foregoing Obſervations.*
Sect. VII. *An Experiment to ſhew that Water is chang'd into Earth.*
Sect. VIII. *Other Experiments proving the ſame.*
Sect. IX. *That living Creatures, Plants, Minerals, and even Metals themſelves are produced from Water ſhewn Experimentally.*
Sect. X. *The Aſcent of the Water into the Air.*
Sect. XI. *How ſuch Aſcent happens.*
Sect. XII. *Experiments proving that Air adheres to other Bodies.*
Sect. XIII. *Experiments to ſhew that Fire will cleave to ſolid Bodies.*

Sect. XIV. *Fire will also leave to Water, proved Experimentally.*
Sect. XV. *Three Consequences from the last Experiment.*
Sect. XVI. *Water and Fire produce a Composition lighter than Air.*
Sect. XVII. *Water must be divided into exceeding small Particles in order to be evaporated.*
Sect. XVIII. *Vapors ascend both by Heat and Cold.*
Sect. XIX. *The Laws of Hydrostaticks.*
Sect. XX. and XXI. *The Vapors in the Air adapt themselves to these Hydrostatical Laws; shewn by several Experiments.*
Sect. XXII. *How Vapors float in the Air.*
Sect. XXIII. *Experiments shewing how Vapors can descend.*
Sect. XXIV. *Vapors Descend by the Separation of the Particles of Fire from them.*
Sect. XXV. *Experiments proving the descent of Vapors by Airs becoming lighter.*
Sect. XXVI. *Cold produces the same effect, shewn experimentally.*
Sect. XXVII. *The Motion of Vapors from one place to another is necessary.*
Sect. XXVIII. *An Experiment proving that the watry Vapors leave their Salts behind them.*
Sect. XXIX. *If the Earth were Mathematically round, the Rains would seldom fall where they were wanted.*
Sect. XXX. *Convictions from thence.*
Sect. XXXI. *Mountains serve to collect watry Vapors from the Air.*
Sect. XXXII. *Fountains and Rivers proceed from Mountains.*
Sect. XXXIII. *The furnishing us with Springs and Rivers, is a principal use of Mountains.*
Sect. XXXIV. *Convictions from the foregoing Observations.*
Sect. XXXV. Egypt *moisten'd by the Nile without Rain.*
Sect. XXXVI. *The fertility of* Egypt.
Sect. XXXVII. *Convictions from the foregoing Observations.*

Sect

Sect. XXXVIII. *Mountains collect Watry Vapors first by Winds.*
Sect. XXXIX. *Secondly Vapors are collected by Coldneſs of Mountains and upper Regions of the Air.*
Sect. XL. *Thirdly, Vapors are collected by Shadows, proved experimentally.*
Sect. XLI. *Fourthly, Other Shadows give occaſion to the concourſe of Vapors proved by Experiments.*
Sect. XLII. *Vapors ſufficient to produce Rivers.*
Sect. XLIII. *The Method of computing the quantity of Rain water falling in a certain time.*
Sect. XLIV. *The Rain of* Paris *compared with that of* Liſle.
Sect. XLV. *Rain-water alone ſufficient for Rivers.*
Sect. XLVI. *There is more Water in the Air than what deſcends in Rain.*
Sect. XLVII. *Exhalations from Canals and Ditches.*
Sect. XLVIII. *Experiments to ſhew that Evaporations are likewiſe produced by Cold.*
Sect. XLIX. *Objections anſwer'd.*
Sect. L. *A Calculation after the rate of a Half-Inch daily Exhalation.*
Sect. LI. *Convictions from the foregoing, and a Word or two about the Air—Salt.*
Sect. LII. *The Wonders of the Nile.*
Sect. LIII. *Convictions from the foregoing Obſervations.*
Sect. LIV. *The Diſpoſition or Fitneſs of Mountains for the aforeſaid Purpoſes; and Convictions from thence.*
Sect. LV. *Rivers require place wherein to diſcharge their Waters.*
Sect. LVI. *Salt preſerves the Sea from Corruption.*
Sect. LVII. *Of Bayes and Gulfs of the Sea for the Reception of Rivers.*
Sect. LVIII. *The Uſes of the Sea.*
Sect. LIX. *The force of the Sea in bearing Burdens, and Convictions from thence.*
Sect. LX. *The ſame Arguments corroborated.*
Sect. LXI. *The Fiſhes of the Sea.*
Sect. LXII. *The Circulation of Waters preſerves the Land from overflowing.*

Sect. LXIII. *Of the Dykes or Sea Banks of* Holland.
Sect. LXIV. *Sand ſtops the Sea, and proceeds from it.*
Sect. LXV. *The* Engliſh *Channel preſerves* Holland.
Sect. LXVI. *The cauſe of ebbing and flowing deſignedly omitted.*
Sect. LXVII. *Water beſtowed in ſuch great abundance, and for ſo many Ages gratis upon Living Creatures.*

CONTEMPLATION XX.

Of the Earth.

Sect. I. *Tranſition to the Earth.*
Sect. II. *The Earth produces Graſs, Corn, &c.*
Sect. III. *Beaſts or Cattle are Kitchins for the Graſs.*
Sect. IV. *Convictions from the foregoing Obſervations.*
Sect. V. *Different Productions and Powers from the ſame Earth.*
Sect. VI. *Convictions from the foregoing Obſervations.*
Sect. VII. *Earth is never conſumed, nor becomes entirely barren.*
Sect. VIII. *An Experiment, proving that Air makes the Earth fruitful.*
Sect. IX. *Convictions from thence.*
Sect. X. *The Earth ſeems to be render'd Loathſom by Filth and Naſtineſs.*
Sect. XI. *Such Loathſomneſs prevented, and Convictions from thence.*
Sect. XII. *The Circulation of almoſt all things from Earth to Earth, and Convictions from thence.*
Sect. XIII. *Several Texts of Scripture proving the ſame, and Convictions from the whole.*
Sect. XIV. *An Experiment about diſtilled Earth.*
Sect. XV. *The Earth produces Inſtruments applicable to the rendering itſelf more uſeful.*
Sect. XVI. *Of Alchymiſts, and an Explanation of the Texts,* Exod. xxxii. 20. Deut. ix. 21. *about Gold.*
Sect. XVII. *Gold may be burnt and reduced to Duſt.*
Sect. XVIII. *About Precious Stones.*
Sect. XIX. *About the Loadſtone.*

Sect.

Sect. XX. *When the virtue of the Loadstone was discover'd.*
Sect. XXI. *The Roundness of the Earth.*
Sect. XXII. *The whole Earth is a flattish Bowl.*
Sect. XXIII. *The Gravity of all Earthly Bodies.*
Sect. XXIV. XXV. *The center of the Earth is a nothing.*
Sect. XXVI. *The Globe of the Earth keeps the same Obliquity.*
Sect. XXVII. *Without such obliquity of the Earth there would be reason to apprehend a general Destruction.*
Sect. XXVIII. *Convictions from thence.*
Sect. XXIX. *The Earth remains above the Waters notwithstanding its greater Gravity.*
Sect. XXX. *Concerning the Torrid Zone.*
Sect. XXXI. *The Torrid Zone inhabitable by the means of Mountains.*
Sect. XXXII. *The Inundation of Rivers do likewise render the Torrid Zone Habitable.*
Sect. XXXIII. *Convictions from thence.*
Sect. XXXIV. *Concerning the Temparate Zones.*
Sect. XXXV. *The Advantages of the most Northern Parts.*
Sect. XXXVI. *The Christian Religion is no Art to Politicians.*
Sect. XXXVII. *Atheists differ from the wisest Men.*
Sect. XXXVIII. *Concerning the Frigid Zones.*
Sect. XXXIX. *The impossibility of approaching the Poles*

CONTEMPLATION XXI.
Of Fire.

Sect. I. *Transition to Fire.*
Sect. II. *The Inconveniencies that would befal us if there were no such thing as Fire in the World.*
Sect. III. *Convictions from thence.*
Sect. IV. *It is still uncertain what Fire is.*
Sect. V. *The first Notion concerning Fire.*
Sect. VI. *The Second Notion; Fire seems to be a particular Matter.*
Sect. VII. *The first Reason for the aboveſaid Opinion.*
Sect. VIII. *The second Reason, and an Experiment.*
Sect. IX. *The third Reason, and an Experiment.*

Sect.

The CONTENTS.

Sect. X. and XI. *The fourth Reason, and several Experiments.*
Sect. XII. *The fifth Reason, and several Experiments.*
Sect. XIII. XIV. *The sixth Reason, and an Experiment.*
Sect. XV. *Convictions from the foregoing Observations.*
Sect. XVI. *The great Abundance and Superfluity of Fire.*
Sect. XVII. *The Wisdom of him who restrains the Power of Fire.*
Sect. XVIII. *An Historical Account of Fire in the Bowels of the Earth.*
Sect. XIX. *Fire in the Air, and an Experiment.*
Sect. XX. *Convictions from the foregoing Observations.*
Sect. XXI. *Convictions from restraining the Power of Fire.*
Sect. XXII. *After what manner the Fire of the Air and Heavens is preserved.*
Sect. XXIII. *All the Water in the World not sufficient to extinguish this Fire, shewn by several Experiments.*
Sect. XXIV. *Some Experiments about the Phosphorus.*
Sect. XXV. *Of a fluid Phosphorus.*
Sect. XXVI. *The Preparation of a Phosphorus.*
Sect. XXVII. *Convictions from the foregoing Observations.*

CONTEMPLATION XXI.

Of Beasts, Fowles and Fishes.

Sect. I. *Transition to the Beasts.*
Sect. II. and III. *Concerning tame and wild Beasts; and the Text in* Gen. ix. 2. *relating to the same.*
Sect. IV. *The Structure of Beasts in general, and Convictions from thence.*
Sect. V. *Of Procreation in general.*
Sect. VI. *Procreation perform'd after various Manners.*
Sect. VII. *Animals of both Sexes.*
Sect. VIII. *Convictions from the foregoing Observations.*
Sect. IX. *Young Ones produce upon the back of a* Pipal.
Sect. X. *The Food of Animals.*
Sect. XI. *The Motion of Animals in general.*
Sect. XII. *The Structure of Birds.*
Sect. XIII. *The hollow Tubes or Bones of a Bird.*

Sect.

The CONTENTS.

Sect. XIV. *The Cartilages in the Joints: and Convictions from thence.*
Sect. XV. *How are moved in flying.*
Sect. XVI. *The wonderful Structure of the Wings.*
Sect. XVII. *Convictions from the foregoing Observations.*
Sect. XVIII. *Other Reflections upon the Structure of Birds.*
Sect. XIX. *Of the Feet of Water-Fowl.*
Sect XX. *Of the Tails of Birds.*
Sect. XXI. *The Center of Gravity, and Force of the Muscles of the Wings.*
Sect. XXII. *Convictions from the foregoing Observations.*
Sect. XXIII. *Of the Support of Birds.*
Sect. XXIV. *Transition to the Fishes.*
Sect. XXV. *The Miracle of Fishes living under Water, and Convictions from thence.*
Sect. XXVI. XXVII. XXVIII. *How Fishes Balance themselves in and against the Waters, illustrated by several Experiments.*
Sect. XXIX. *The Effect of Cold and Heat, and of a greater or lesser Column of Water pressing upon Fishes shewn Experimentally.*
Sect. XXX. *Convictions from the foregoing Observations.*
Sect. XXXI. *Fishes Swim with their Tails.*
Sect. XXXII. *The use of their Finns.*
Sect. XXXIII. *Creatures that live in the Air see confusedly in the Water.*
Sect. XXXIV. *To prevent this confused Sight, Fishes are endowed with rounder Eyes.*
Sect. XXXV. XXXVI. *The Fruitfulness or Number of Fishes.*
Sect. XXXVII. *The Curse appears from the Production of Fishes.*
Sect. XXXVIII. *Creeping Creatures not yet thoroughly known.*
Sect. XXXIX. *Of Insects, Silk-worms, Caterpillars, &c.*
Sect XL. *Of the small Animalcula in general.*
Sect. LXI. *Of the Eyes of a fly called Rombott, and Convictions from thence.*
Sect. XLII. *Something of the beginning of Action in Beasts.*

CON-

The CONTENTS.

CONTEMPLATION XXIII.

Of Plants.

Sect. I. *Transition to the* Plants *in general.*

Sect. II. *Without Earth and Water no Plants will spring from their Seeds.*

Sect. III. *Every Seed has its Seed-Plant.*

Sect. IV. *The Seed-root and* Pluma *in a Bean.*

Sect. V. *Every Plant has two Roots.*

Sect. VI, *The Cavity in the* Bean *for the Pluma.*

Sect. VII. *The hole in the Skin for the Roots-Sprout.*

Sect. VIII. *The nutricious Juice or Sap changes its way in the Seed.*

Sect. IX. *The Seed Leaves, and their Use.*

Sect. X. *Of the Expansion or Unfolding the Seed-Plant, with an Experiment of Mr.* Dodart *thereupon.*

Sect. XI. *Whether the Seed-Plants contain the following ones.*

Sect. XII. *Transition to* Roots, *and Trunks of Plants.*

Sect. XIII. *The Structure of the Root, and its Parts.*

Sect. XIV. *This Structure represented in the* Pepper-Root.

Sect. XV. *The Structure of the Trunk in an* Ash-Tree.

Sect. XVI. *The Trunk grows upward and the Root downward.*

Sect. XVII, XVIII, XIX. *Three Experiments made upon Beans, Acorns, and other Plants.*

Sect. XX. *Convictions from the foregoing Observations.*

Sect. XXI. *The* Knots *and* Buttons *of Plants, and Convictions from thence.*

Sect. XXII. *The Structure of* Leaves, *and their Usefulness.*

Sect. XXIII, XXIV, XXV. *Several Experiments to shew the Perspiration of Leaves.*

Sect. XXVI, XXVII. *The Structure of* Flowers, *with their Supporters and without.*

Sect. XXVIII. *Some Singularities about Flowers.*

Sect. XXIX. *The little Threads of Plants, and Convictions from thence.*

Sect. XXX. *Of the Curse of the Earth.*

Sect. XXXI, XXXII. *Plants don't yield as much as they are able, and a proof thereof shewn in Trees.*

Sect. XXXIII. *Convictions from the foregoing Observations.*

Sect. XXXIV. *Of* Sea Plants.

Sect. XXXV. *Convictions from all that has been said above.*

FINIS.

MVSEVM BRITAN